Renewable energy in emerging and developing countries
An increase by a factor of 3 can be achieved by 2020
Final report RECIPES project

Brussels, November 2006

Project summary

Recipes for the implementation of renewable energy sources that benefit the local and global environment, the socio-economic situation in emerging and developing countries and the European industry

SIXTH FRAMEWORK PROGRAMME PRIORITY 3
Underpinning the economic potential and cohesion of a larger and more integrated EU

SPECIFIC SUPPORT ACTION
Project Acronym: RECIPES
Project full title: Renewable Energy in emerging and developing countries: Current situation, market Potential and recommendations for a win-win-win for EU industry, the Environment and local Socio-economic development
Contract number: 513733
Start date of contract: 4th January 2005
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Abbreviations and definitions

**CO₂**  
Carbon dioxide: a gas that contributes to the greenhouse effect. Greenhouse gas emissions are expressed in carbon dioxide equivalents.

**EC**  
European Commission

**EDCs**  
Emerging and Developing Countries

**EDI**  
Energy Development Index

**EIA**  
Energy Information Administration of the US Department of Energy

**EU**  
European Union

**GJ**  

**HEGC**  
High Economic Growth Case

**IEA**  
International Energy Agency

**IEO**  
International Energy Outlook

**kton**  
Kilo ton = $10^6$ kg

**LEGC**  
Low Economic Growth Case

**MDG**  
Millennium Development Goals. The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world’s countries and all the world’s leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world’s poorest.

**Mtoe**  
Mega Tonnes Oil Equivalent. Unit of energy quantity, used worldwide as the unit for the energy consumption of a country.

**Mton**  
Mega ton = $10^9$ kg

**MW**  
Megawatt. Unit of power generation capacity used for fossil plants as well as for wind-energy, hydro and other RE sources.

**RE %**  
Percentage of RE as part of the total energy supply or electricity supply. We indicate where RE includes or excludes large hydro. The RE-percentage in relation to the total primary energy consumption relates to the countries total TPES including traditional biomass. Where this is not the case it is indicated. The RE-percentage in relation to the total electricity supply: this relates to the total electricity produced, not to the primary energy needed to produce the electricity.

**RE**  
Renewable Energy. There is no universally accepted definition of renewable energy. Especially some techniques like large hydro or energy from waste are disputable. We use the definition of each country if it relates directly to the targets set. In the reports of the in-depth country studies and the extrapolation to the 99 other countries we state what definitions are used. Traditional biomass is not regarded to be RE.

**RECIPES**  
Renewable Energy in emerging and developing countries: Current situation, market Potential and recommendations for a win-win-win
for EU industry, the Environment and local Socio-economic development.

REMP  RE Market Potential. The amount of renewable energy which, given all possible restrictions (practical, economical, juridical, etc.) is likely to be produced.

RES  Renewable Energy Sources (see also RE)

RET  Renewable Energy Technologies (see also RE)

TP  Technical Renewable Energy Potential; the amount of renewable energy which, based on the best available renewable energy technologies, can be produced. (i.e. for solar and wind energy this is in almost every country unlimited while geothermal and hydro can have a certain maximum).

TWh  Tera Watt hour = 10^9 kWh

TPES  Total Primary Energy Supply: includes all RE, traditional biomass and fossil fuels including those used to generate electricity.

TREMP  Theoretical Renewable Energy Market Potential, based on the energy demand as a consequence of growth in energy, a market due to the introduction of RE energy and a market due to (the possible) replacement of old energy equipment

UN  United Nations

UNDP  United Nations Development Program

US  United States

WEC  World Energy Council

Wp  Watt peak (also kWp and MWp). Unit of power generation capacity especially used for photovoltaic systems (solar cells). The energy output depends on the quantity of solar energy on the solar cells.
Foreword

The RECIPES project was named this way because the project team had the ambition to look for recipes that could improve the implementation of renewable energy technologies in emerging and developing countries.

The team’s basic idea was to look for the market potentials for renewables in emerging and developing countries. Based on the potentials that were calculated, the possibilities for the European renewables industry and the local social-economic and environmental effects of implementing the different technologies where analysed. The calculation of market potentials is based on detailed country studies performed by local experts.

The European Commission funded the project in order to obtain results to be used for policy support. However, we also identified other potential (non-paying) clients for the results of the project:

- European renewables industry;
- Energy actors like governments and energy producing companies, in emerging and developing countries;
- Financial organisations investing in renewables.

When setting up and carrying out the project we tried to address their needs as well.

Both the wealth of data and information gathered during the project and the results of the analysis of this information can be interesting and useful for these ‘clients’.

The project team has been working intensively the last two years to gather all information and to come up with meaningful results. We are aware of the limited span of influence of this project considering all other activities taking place in this area. However we feel we have added something new: no other study has so far provided data on the RE situation in emerging and developing countries at such a level of detail and in such a comprehensive and standardised way.

The project team would like to thank everyone involved (either directly or by providing information or opinions) in the RECIPES project for his or her cooperation. Their input and information were of crucial importance for the quality and relevance of the project results.

Brussels, November 2006
Table: the RECIPES consortium, local experts and Advisory Board

<table>
<thead>
<tr>
<th>Expert</th>
<th>Organisation</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project consortium</strong></td>
<td></td>
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<tr>
<td>Els Sonnemans</td>
<td>EBM Consult</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Emiel Hanekamp</td>
<td>Partners for Innovation</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Eric Evrard</td>
<td>Prospect C&amp;S</td>
<td>Belgium</td>
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<tr>
<td>Paul Cognaud</td>
<td>Partners for Innovation</td>
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<tr>
<td>Peter Karsch</td>
<td>Partners for Innovation</td>
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<tr>
<td>Peter Vissers</td>
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<tr>
<td>Richard Oomen</td>
<td>EBM Consult</td>
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</tr>
<tr>
<td>Victorio Oxilia Dávalos</td>
<td>ESENERG</td>
<td>Paraguay</td>
</tr>
<tr>
<td>Wolfgang Lutz</td>
<td>ESENERG</td>
<td>Paraguay / Netherlands</td>
</tr>
<tr>
<td><strong>Local experts</strong></td>
<td></td>
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<tr>
<td>A.K. Ofosu-Ahenkorah</td>
<td>Energy Foundation</td>
<td>Ghana</td>
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<tr>
<td>Chayun Budiono</td>
<td>PT CGI</td>
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<tr>
<td>Dieudonné Goudou</td>
<td>EDER</td>
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<tr>
<td>François Serneels</td>
<td>Kosmos</td>
<td>Belgium / Thailand</td>
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<tr>
<td>Liu Ying</td>
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<td>China</td>
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<tr>
<td>Halleson Dureel Nzene</td>
<td>Global Village Cameroonian</td>
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<tr>
<td>Henry García Bustamante</td>
<td>ESENERG</td>
<td>Peru</td>
</tr>
<tr>
<td>Jason Schäffler</td>
<td>Nano Energy Ltd</td>
<td>South Africa</td>
</tr>
<tr>
<td>Luis A. Vega</td>
<td>Vega Consultants</td>
<td>Hawaii / Pacific Islands</td>
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<tr>
<td>Odón de Buen Rodríguez</td>
<td>ESENERG</td>
<td>Mexico</td>
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<td>Omar Prias Caicedo</td>
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<tr>
<td>Srikanth Subbarao</td>
<td>IT Power India Ltd</td>
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</tr>
<tr>
<td>Timothy Byakola</td>
<td>Climate &amp; Dev. Initiatives</td>
<td>Uganda</td>
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<tr>
<td><strong>Advisory Board</strong></td>
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<tr>
<td>Celio Bermann</td>
<td>PIPGE</td>
<td>Brazil</td>
</tr>
<tr>
<td>Christine Lins</td>
<td>EREC</td>
<td>Belgium</td>
</tr>
<tr>
<td>Claude Turmes</td>
<td>European Parliament</td>
<td>Belgium</td>
</tr>
<tr>
<td>Emil Bédi</td>
<td>INFORSE Europe</td>
<td>Slovakia</td>
</tr>
<tr>
<td>Emilia Van Egmond</td>
<td>Eindhoven University</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Eric Martinot</td>
<td>Tsinghua University</td>
<td>China</td>
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<tr>
<td>Jean Marc Jossart</td>
<td>AEBIOM</td>
<td>Belgium</td>
</tr>
<tr>
<td>Michel Viaud</td>
<td>EPIA</td>
<td>Belgium</td>
</tr>
<tr>
<td>Narendra Kumar Bansal</td>
<td>SMV Devi University</td>
<td>India</td>
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<tr>
<td>Secou Sarr</td>
<td>ENDA</td>
<td>Senegal</td>
</tr>
<tr>
<td>Sven Harmeling</td>
<td>Germanwatch</td>
<td>Germany</td>
</tr>
</tbody>
</table>
Management summary

Introduction
People in developing countries, especially those lacking access to electricity (about 1.6 billion people), could be given priority when implementing renewable energy sources. Developing countries have 80% of the world’s population but consume only 30% of global commercial energy. As energy consumption rises with increases in population and living standards, awareness of the environmental costs of energy and the need to expand access to energy in new ways is growing. Increased recognition of the contribution renewable energy makes to rural development, lower health costs (linked to air pollution), energy independence and climate change mitigation is shifting renewable energy from the fringe to the mainstream of sustainable development.

The European Commission (EC) identified a need for policy-oriented research leading to a better understanding of the existing and future situation with regard to renewable energy in emerging and developing countries. The EC selected the RECIPES project to provide better insight in the market potential of renewable energy in emerging and developing countries, as well as in the related socio-economic effects and opportunities for EU industry. Main aim of the RECIPES project is to provide all stakeholders with information and insights that will enable them to contribute to the implementation of renewable energy in emerging and developing countries.

The actual implementation of renewable energy technologies varies with its use and users. RECIPES is therefore focussed on different market-technology-equipment combinations. The time horizon of the project is 2020, therefore only the market-technology-equipment combinations that are of importance in view of this time horizon are taken into account.

RE market-technology-equipment combinations considered in RECIPES

<table>
<thead>
<tr>
<th>RE market-technology-equipment combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar thermal</td>
</tr>
<tr>
<td>Hot water for residential, commercial and public use in all areas</td>
</tr>
<tr>
<td>Solar thermal processes for industrial use</td>
</tr>
<tr>
<td>Photo voltaic</td>
</tr>
<tr>
<td>Electricity for grid connected single users and large fields</td>
</tr>
<tr>
<td>Electricity for rural areas as stand alone or for local grid</td>
</tr>
<tr>
<td>Wind</td>
</tr>
<tr>
<td>Grid connected electricity from on shore and off-shore wind parks</td>
</tr>
<tr>
<td>Electricity from single turbines, grid connected</td>
</tr>
<tr>
<td>Electricity for rural residential and public services as stand alone or local grid</td>
</tr>
<tr>
<td>Mechanical power (water pumping, milling)</td>
</tr>
<tr>
<td>Geothermal</td>
</tr>
<tr>
<td>Electricity grid connected</td>
</tr>
<tr>
<td>Heat for local industry or public services</td>
</tr>
<tr>
<td>Small and medium size hydro power</td>
</tr>
<tr>
<td>Grid connected electricity (medium size)</td>
</tr>
<tr>
<td>Electricity for rural residential and public services as stand alone or for local grid (small)</td>
</tr>
<tr>
<td>Mechanical power for milling (small)</td>
</tr>
<tr>
<td>Bio-energy</td>
</tr>
<tr>
<td>Cooking and heat for rural residential</td>
</tr>
<tr>
<td>Bio gas for cooking and heating for rural residential</td>
</tr>
<tr>
<td>Stand alone and grid connected, wood and agro waste combustion</td>
</tr>
</tbody>
</table>
When appropriate for a country (and data was available) specific attention is being paid to small renewable energy systems, renewable energy used in industry, water desalination and large hydro. The latter technology is very important in terms of share in electricity generation but also controversial due to its significant environmental and social impacts.

The study includes the 114 emerging and developing countries that are on the INCO list (see Annex 2), of which 15 countries were studied in more detail:

<table>
<thead>
<tr>
<th>Latin America</th>
<th>Asia and Pacific</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>China</td>
<td>Cameroon</td>
</tr>
<tr>
<td>Brazil</td>
<td>India</td>
<td>Ghana</td>
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<tr>
<td>Colombia</td>
<td>Indonesia</td>
<td>Niger</td>
</tr>
<tr>
<td>Mexico</td>
<td>Pacific Islands</td>
<td>South Africa</td>
</tr>
<tr>
<td>Peru</td>
<td>Thailand</td>
<td>Uganda</td>
</tr>
</tbody>
</table>

**Approach and results**

Starting point of the project is the identification of the potential of renewable energy in developing countries. The calculation of the market potentials for 2020 for different renewable energy technologies are based on the technical potential, the effects of different barriers, national policy, practical feasibility, energy market development and economic restrictions. Detailed country studies based on a combination of desk research and interviews provided the necessary information for this exercise.

Based on this potential, quantitative and qualitative assessments are made for the socio-economic and environmental implications and the opportunities for the EU industry. As a last step a comparison was made with other studies, and different validation mechanisms of data and results were carried out.

RECIPIES generates a wealth of (recent) data on: existing renewable situation, the technical potential of renewables; the costs and benefits of increased shares of renewable energy; market potentials for renewables; actual attitudes towards renewables, local socio-economic and environmental impacts of renewables, and barriers and drivers for implementation. For all 114 emerging and developing countries available basic data has been gathered. For 15 selected countries detailed data and information has been brought together.

Besides this final report, the following reports are available:

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1 'Potential' can be market potential, technical potential or other. We have used the following definition: Renewable Energy Market Potential - the amount of renewable energy which, given all possible restrictions (practical, economical, juridical, etc.) is likely to be produced.
- Detailed country reports: 15 detailed studies of the aforementioned countries;
- Country reports: 114 reports of all the countries included on the INCO list;
- A report on opportunities and barriers for EU industry;
- A report on social, economic and environmental performance of energy technologies in emerging and developing countries;
- A report on renewable energy market potential in emerging and developing countries;
- A report describing the RECIPES methodology.

On the RECIPES website (www.energyrecipes.org) all the relevant data collected and reports produced are freely accessible.

Conclusions
The overall conclusions for the RECIPES project are:

*Tripling the renewable energy volume in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and limited opportunities for EU industry*

*At global level, the RE volume increases by a factor of 2 in the reference scenario and potentially by a factor of 3 in the maximum scenario. The percentage of RE within the TPES remains stable in the reference scenario and doubles in the maximum scenario.*

In order to achieve this in the maximum scenario however, there is still a long way to go for all RE technologies. Ambitious targets for RE technologies supported by reliable measures are needed in order to nurture sustainable RE industry and to create the situation where RE could make a real impact on security of supply and imported fuel dependency. The RE technologies that contribute most to these objectives are small / medium hydro, bio-fuels, bio-energy and wind. Other RE technologies contribute to a much lesser extent, however, the local socio-economic impact of these systems can be very positive.
At continent level large differences occur: RE is well established in Latin America, grows quickly in Asia but remains marginal in Africa

Latin America has the highest present RE volume (73 Mtoe) and the greatest RE percentage of TPES (12%). This is largely a result of the contribution of Brazil with its energy policy focused on bio fuels and energy independency. Under the 2020 reference scenario, the RE volume in Latin America grows slightly to 79 Mtoe but not at the pace of growth of the TPES. The RE percentage of TPES therefore goes down from 12 to 6%, highlighting the need to continue ambitious RE policy backed up by robust and reliable measures aimed at maintaining RE industry growth in the longer run.

Under both the reference and the maximum scenario, the RE volume in INCO Asia will surpass the RE volume in Latin America in 2020, because of the strong RE policies that are put in place, the strong growth in energy demand in these countries, and the dimension of these countries. China and India have a large impact on the energy figures for INCO Asia countries, as they account for ¾ of the TPES, in the present situation as well as in 2020.

The present RE production in the African INCO countries, large hydro excluded, is marginal both in absolute figures (0.1 Mtoe) and in percentage of TPES (<0.1%). The reference and maximum scenarios show that RE production will remain marginal in African INCO countries in 2020. These results highlight the critical need for RE development support for the poorest countries, especially for infrastructure, grid connections, and market development. Climatic and political volatility, and economical instability provide stimulants and deterrents for the development of RE in Africa today.
At country level the RE market potential varies even more and is predominantly related to political will and finance availability for RE, except for the poorest countries, where providing access to energy primes.

Large hydro is disputed as RE technology but considered RE in many countries and accounts for 2 to 3 % of TPES.

Large hydro is an important energy technology in emerging and developing countries and is a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances. At the same time however, large hydro is disputed as an RE technology, because of its significant environmental and social impacts.
All Asian and African countries have planned significant investments in large hydro, except South Africa. Under the 2020 reference scenario, in seven out of ten Asian and African countries large hydro is growing at a higher pace than TPES. These countries generally try to mitigate the negative environmental and social impacts of large hydro. They consider large hydro to be crucial for their national energy balance and decided to invest in it, and to integrate large hydro into their water management.

**Renewable energy technologies (RET) have a more positive effect on socio-economic development and environmental issues in developing countries than non RETs**

Looking at the Millennium Development Goals related to energy, the country trade balance, security of supply and consumer energy costs, the 123 experts consulted in the RECIPES study clearly indicated that renewable energy technologies have a more positive socio-economic impact than non RETs.

**Solar, hydro, bio-energy and wind technologies reportedly contribute most, fossil based and nuclear technologies least**

The following table shows the scores of different technologies on various social, economic and environmental aspects as indicated by the experts consulted in the RECIPES project.
Overall (relative) scores of the survey

<table>
<thead>
<tr>
<th>Energy technologies</th>
<th>Bio-energy</th>
<th>Fossil fuel based</th>
<th>Geothermal</th>
<th>Hydro</th>
<th>Nuclear</th>
<th>Solar</th>
<th>Traditional biomass</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>National job creation</td>
<td>0.83</td>
<td>0.35</td>
<td>0.36</td>
<td>0.75</td>
<td>-0.06</td>
<td>0.77</td>
<td>0.49</td>
<td>0.64</td>
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<tr>
<td>Agricultural activities</td>
<td>0.87</td>
<td>0.33</td>
<td>0.22</td>
<td>0.71</td>
<td>0.00</td>
<td>0.73</td>
<td>0.43</td>
<td>0.58</td>
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<tr>
<td>Safe cooking of food</td>
<td>0.75</td>
<td>0.38</td>
<td>0.21</td>
<td>0.41</td>
<td>0.00</td>
<td>0.69</td>
<td>0.30</td>
<td>0.27</td>
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<tr>
<td>Conditions for education</td>
<td>0.68</td>
<td>0.33</td>
<td>0.41</td>
<td>0.75</td>
<td>0.00</td>
<td>0.88</td>
<td>0.07</td>
<td>0.68</td>
</tr>
<tr>
<td>Gender equality</td>
<td>0.73</td>
<td>0.35</td>
<td>0.32</td>
<td>0.63</td>
<td>0.00</td>
<td>0.77</td>
<td>0.04</td>
<td>0.53</td>
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<td>Indoor air pollution</td>
<td>0.66</td>
<td>-0.16</td>
<td>0.46</td>
<td>0.61</td>
<td>0.00</td>
<td>0.82</td>
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<td>Loss environmental resources</td>
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<td>-0.05</td>
<td>0.59</td>
<td>0.58</td>
<td>-0.21</td>
<td>-0.14</td>
<td>0.19</td>
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<td>Country trade balance</td>
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<td>-0.15</td>
<td>0.45</td>
<td>0.73</td>
<td>0.03</td>
<td>0.68</td>
<td>0.28</td>
<td>0.64</td>
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<tr>
<td>Energy security</td>
<td>0.83</td>
<td>-0.05</td>
<td>0.62</td>
<td>0.72</td>
<td>0.02</td>
<td>0.83</td>
<td>0.37</td>
<td>0.78</td>
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<td>Energy costs</td>
<td>0.24</td>
<td>-0.45</td>
<td>-0.14</td>
<td>0.22</td>
<td>-0.34</td>
<td>-0.16</td>
<td>0.25</td>
<td>-0.01</td>
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<tr>
<td>Overall score</td>
<td>6.70</td>
<td>0.87</td>
<td>3.51</td>
<td>6.11</td>
<td>-0.57</td>
<td>6.90</td>
<td>2.27</td>
<td>5.39</td>
</tr>
</tbody>
</table>

Best technology Second best technology Worst technology

An increased volume of renewable energy in emerging and developing countries presents opportunities for EU industry, but there is no low hanging fruit

The market for renewable energy in emerging and developing countries in 2020 (between 87 and 250 Mtoe) can be comparable in volume with the market in the EU 15 countries (228 Mtoe).

EU industry has to compete with local production and competitors from other economies

The opportunities for EU industry are limited because EU industry has to compete with home production and competitors from other economies. Furthermore, there are restrictive non-technical conditions in some countries. However, there are opportunities that include providing goods and services; hardware and equipment as well as transfer of know-how, consultancy and training.

A number of risks and barriers are associated with doing business in emerging and developing countries

The risk level is also an important aspect when companies are considering to do business in a certain country. In the RECIPES project, an overall opportunity level has been established for each country included in the study, based on aspects like:
General country risk level; political and economic country stability (based on AON risk map);
RE Industry and Import; readiness of countries to participate in CDM projects, availability of import facilities and the openness of a country to import / foreign investments in general (information gathered by local experts in the 15 case study countries);
Origin of currently installed equipment;
Available knowledge and organisational degree for specific technologies.

Best opportunities for EU industry are in Asia, Pacific and Latin America. Africa is considered to be difficult, except South Africa.
Introduction

Background
The Johannesburg conclusions clearly raise the point of increasing the share of renewable energy sources. Developing countries, especially those lacking electricity (about 1.6 billion people), could be prioritised for the installation of renewable energy sources. Recently energy has been identified as enabler for reaching the Millennium Development Goals.

Developing countries have 80% of the world’s population but consume only 30% of global commercial energy. As energy consumption rises with increases in population size and living standards, awareness is growing about the environmental costs of energy and the need to expand access to energy in new ways. Increased recognition of the contribution renewable energy makes to rural development, lower health costs (linked to air pollution), energy independence, and climate change mitigation is shifting renewable energy from the fringe to the mainstream of sustainable development.

The European Commission (EC) identified a need for policy-oriented research leading to a better understanding of the existing and future situation with regard to renewable energy in emerging and developing countries. The EC selected the RECIPES project to provide better insight in the market potential of renewable energy in emerging and developing countries, as well as in the related socio-economic effects and opportunities for EU industry.

RECIPES approach
‘RECIPES’ is a study into the implementation of renewable energy sources (RES) in emerging and developing countries (EDCs), funded by the European Commission. Main aim of the project is to provide all stakeholders with information and insights that will enable them to contribute to the implementation of renewable energy in emerging and developing countries.

The approach is bottom-up (Figure 0.1): the project has started with data and information gathering, detailed country studies, interviews and questionnaires; secondly the analysis of the information, calculations and comparison with other studies took place and thirdly recommendations were formulated. Throughout the project we sought for feedback from stakeholders and validation of data and results.
Renewable energy technologies
There are many different renewable energy technologies. The actual implementation of these technologies varies with its use and users. We felt that analyses on renewables should be related to specific uses and users (market), and installations (equipment). Therefore we started with identifying different market-technology-equipment combinations. The time horizon of the project is 2020, therefore only the market-technology-equipment combinations that are of importance in view of this time horizon are taken into account. The market-technology-equipment combinations considered are listed below.

Table 0.1: RE market-technology-equipment combinations in RECIPES

<table>
<thead>
<tr>
<th>RE</th>
<th>RE market-technology-equipment combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar thermal</td>
<td>✪ Hot water for residential, commercial and public use in urban and residential areas</td>
</tr>
<tr>
<td></td>
<td>✪ Solar thermal processes for industrial use</td>
</tr>
<tr>
<td>Photo voltaic</td>
<td>✪ Grid connected electricity from on shore and off-shore wind parks</td>
</tr>
<tr>
<td></td>
<td>✪ Electricity for single turbines, grid connected</td>
</tr>
<tr>
<td></td>
<td>✪ Electricity for rural residential and public services as stand alone or for local grid</td>
</tr>
<tr>
<td>Wind</td>
<td>✪ Electricity grid connected</td>
</tr>
<tr>
<td></td>
<td>✪ Heat for local industry or public services</td>
</tr>
<tr>
<td>Geothermal</td>
<td>✪ Grid connected electricity (medium size)</td>
</tr>
<tr>
<td>Small and medium</td>
<td>✪ Electricity for rural residential and public services as stand</td>
</tr>
<tr>
<td>size hydro power</td>
<td></td>
</tr>
<tr>
<td>RE</td>
<td>RE market-technology-equipment combination</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>alone or for local grid (small)</td>
</tr>
<tr>
<td></td>
<td>⚫ Mechanical power for milling (small)</td>
</tr>
<tr>
<td></td>
<td>⚫ Cooking and heat for rural residential</td>
</tr>
<tr>
<td></td>
<td>⚫ Bio gas for cooking and heating for rural residential</td>
</tr>
<tr>
<td></td>
<td>⚫ Stand alone and grid connected, wood and agro waste combustion or agro waste digestion for cogeneration</td>
</tr>
<tr>
<td></td>
<td>⚫ Grid connected electricity with wood combustion and gasification</td>
</tr>
<tr>
<td></td>
<td>⚫ Grid connected electricity with agro digesters</td>
</tr>
<tr>
<td></td>
<td>⚫ Grid connected electricity with incineration of city waste</td>
</tr>
<tr>
<td></td>
<td>⚫ Bio fuels from energy crops</td>
</tr>
</tbody>
</table>

When appropriate for a country (and data was available) specific attention is being paid to small renewable energy systems, renewable energy used in industry and water desalination.

**Large hydro**
Large hydro is an important energy technology in emerging and developing countries and a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances. At the same time, however, large hydro is disputed as RE technology, because of its significant environmental and social impacts.

In order to be able to present comparable figures, and to take account of the disputed status of large hydro as RE technology, we decided to give large hydro a 'status aparte' in the RECIPES project. In a separate section (section 1.4) the results for large hydro are presented.

**RECIPES countries**
The 114 emerging and developing countries studied are on the INCO list (see Annex 2). The red coloured countries of the Figure 0.2 are on the INCO list. Dark red coloured countries are the 15 RECIPES countries for which detailed country studies have been conducted.
The 15 countries studied in more detail are:

**Latin America**
- Argentina
- Brazil
- Colombia
- Mexico
- Peru

**Asia and Pacific**
- China
- India
- Indonesia
- Pacific Islands
- Thailand

**Africa**
- Cameroon
- Ghana
- Niger
- South Africa
- Uganda

**Results**

The project generates a wealth of (recent) data on: existing renewable situation, the technical potential of renewables; the costs and benefits of increased shares of renewable energy; market potentials for renewables; actual attitude towards renewables, local socio-economic and environmental impact of renewables, and barriers and drivers. For all 114 emerging and developing countries available basic data has been gathered. For 15 selected countries detailed data and information has been brought together.

Besides this final report, the following reports are available:

- Detailed country reports: 15 detailed studies of the aforementioned countries;
- Country reports: 114 reports of all the countries included on the INCO list;
- A report on opportunities and barriers for EU industry;
- A report on social, economic and environmental performance of energy technologies in emerging and developing countries;
- A report on renewable energy market potential in emerging and developing countries;
- A report describing the RECIPES methodology.

On the RECIPES website ([www.energycipes.org](http://www.energycipes.org)) all the relevant data collected and reports produced are freely accessible. This website has an
integrated database section including information regarding the current situation and technical potential for renewable energy options in each of the 114 emerging and developing countries. Users can access the database freely and with the help of reporting and comparison tools, can select their information of choice.

This report
This report presents the main results of the RECIPES project. It is based upon in-depth case studies for 15 emerging and developing countries, interviews with key stakeholders in these countries, research into the characteristics of the 99 other emerging and developing countries, and a survey on socio-economic effects of renewable energy that includes the input of 123 experts from all over the world. In order to discuss and validate the results and conclusions of the project, a workshop will be held with experts on 7 December 2006 in Brussels.

The recommendations of the RECIPES project address a variety of stakeholders involved in policy making, programme management and implementation of renewable energy in emerging and developing countries. Short and long-term recommendations are proposed which would ultimately lead to more coherent and efficient policy making on renewable energy in these countries.

The main results of the project are presented in this report. The central finding is that ‘Tripling the renewable energy volume in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and limited opportunities for EU industry’. This is detailed hereafter in chapters 1, 2 and 3. In chapter 1 the market potential for renewables is further discussed. Chapter 2 describes the local socio-economic and environmental impact of RE technologies in emerging and developing countries. Chapter 3 describes the opportunities and barriers for EU industry associated with the identified market potential.
Tripling the renewable energy volume in emerging and developing countries in 2020 is possible in a maximum scenario, with a positive socio-economic impact and limited opportunities for EU industry.
1. With present policy the volume of renewable energy in emerging and developing countries will double in 2020, with extra effort this volume can triple.

1.1. At global level, RE volume increases with a factor 2 in the reference scenario and potentially with a factor 3 in the maximum scenario. The percentage of RE within the TPES remains stable in the reference scenario and doubles in the maximum scenario.

The RECIPES project includes an assessment of the market potential of renewable energy for the 114 emerging and developing countries of the INCO list. In-depth studies for 15 emerging and developing countries on the market potential for different market technology combinations form the basis of this assessment.

The RE-potential in 2020 for the 15 countries was assessed using information gathered by local experts. The local experts collected this information by means of desk research and contacts (interviews, surveys) with national stakeholders (policy makers, industry experts, other stakeholders). The data was structured in five parts and is annexed to the market potential reports of the 15 countries:

- **A Questionnaire**: data provided by the local expert on the present energy situation, the energy policy and the various market-technology combinations;
- **B Energy and policy**: a description by the local expert of the national energy policy and the characteristics of the energy supply.
- **C Country maps**: these maps contain information on population, (energy) infrastructure, existing RE and available RE sources.
- **D Project description**: description of some RE projects by the local expert with emphasis on non-technical experiences and lessons learned.
- **E Interviews with stakeholders**: interviews with selected local actors in energy and renewable energy (not public).

On the basis of the information gathered by the local experts, the RECIPES team has defined the main drivers and barriers for the various RE technologies and developed scenarios for further RE market implementation. The information that was gathered by the local experts has been compared with data available in international publications, and was checked with the expert if differences occurred.

In the RECIPES project, two scenarios have been defined. The ‘reference scenario’ describes the future development of a market technology combination if the present situation remains unchanged, including the estimated impact of existing policy measures by 2020. The scenario described as the ‘maximum scenario’ leads to the largest RE output per technology by 2020; the drivers for this maximum scenario can vary per market technology combination and per country. In many cases the maximum scenario was either a strong policy scenario or a finance availability scenario, or a combination of these two. The
maximum scenario is based upon positive but realistic changes in drivers and barriers.

The results for the 15 case study countries were extrapolated to the 114 INCO countries. Extrapolation was done on the basis of a categorisation according to the countries’ level of development (poorest, poor, average, richest). The extrapolation factor was only 1.3, since all emerging and developing countries with a high TPES are included in the 15 countries.

Figures 1.1 and 1.2 show the results of this extrapolation. Under the ‘reference scenario’, the present RE volume in 114 INCO countries, large hydro excluded, will double in 2020, from 95 to 182 Mtoe. The present TPES in 114 INCO countries will also almost double in this period, from 3,600 Mtoe to 6,000 Mtoe (factor 1.7). Under the reference scenario the RE percentage of TPES remains stable at 3%.

Under the ‘maximum scenario’, that combines strong policy at national and international level with finance availability, tripling of the RE volume in 2020 to 345 Mtoe is possible. In this case the RE percentage of TPES will grow to 6% and thus grows at a more rapid pace than TPES.

The volumes of large hydro, that has a ‘status aparte’ in RECIPES as explained in the introduction, are presented in section 1.4.

Figure 1.1: RE volume in 114 INCO countries, large hydro excluded
In order to achieve this maximum scenario there is however still a long way to go for all RE technologies. Ambitious targets for RE technologies, supported by reliable measures are needed in order to nurture sustainable RE industry and to create the situation in which RE could make a real impact on security of supply and imported fuel dependency. The RE technologies that contribute most to these objectives are small / medium hydro, bio fuels, bio energy and wind. Other RE technologies contribute to a much lesser extent, however, the local socio-economic impact of these systems can be very positive. Traditional biomass is not considered to be RE but has been included in the TPES.

For all the countries, effective market drivers are important to achieve the market potential. These market drivers include finance availability, prioritised access to the grid, cost effectiveness, capacity building factors (such as local knowledge and technical education level and skills for effective contracting) and awareness building. These drivers all rely on the effectiveness of the underlying energy policy and organisation structure of the energy sector.

It must be emphasised that we have assessed a realistic market potential; we did not define scenarios on just the technical potential, nor did we aim at a politically or environmentally desirable potential. It is also important to note that the actual implementation of RE may well be higher than the RECIPES maximum scenario. Especially possible developments in the bio fuels sector and in the use of waste from the agro industry (although waste is not always regarded as a renewable source), can increase the aforementioned figures. In most countries that were studied there is however no policy for these energy options. In many countries there is a discussion on the land use for energy production instead of food production. Furthermore, there is generally little
experience with these energy options; therefore it was impossible to assess a reliable market potential for 2020 for these RE options in all the countries.

1.2. At continent level large differences occur: RE is well established in Latin America, grows quickly in Asia but remains marginal in Africa

Latin America and Caribbean (33 INCO countries)
The continent with the highest present RE volume (73 Mtoe) and the greatest RE percentage of TPES (12%) is Latin America. This is largely due to Brazil with its energy policy focused on bio fuels and energy independency; in the present situation Brazil accounts for 58 of the 73 Mtoe of the RE volume. However, also the other Latin American and Caribbean countries have or are developing a policy towards RE.

Under the 2020 reference scenario, the RE volume in Latin America grows slightly to 79 Mtoe but not at the pace of growth of the TPES. The RE percentage of TPES therefore goes down from 12 to 6%, highlighting the need for a continuously ambitious RE policy backed up by robust and reliable measures to be able to sustain RE industry growth for the longer term. This is especially the case in Brazil, where the RE contribution drops from 28% in the present situation to 16% in the 2020 reference scenario, but smaller decreases are also shown in Argentina and Mexico.

In the 2020 maximum scenario, the RE volume in Latin America almost doubles compared with the present situation (133 Mtoe instead of 73) while the percentage of RE within the TPES remains almost stable (it drops 1 percentage point to 11%). In this scenario the RE volumes of Argentina and Mexico grow from 3 to about 11 Mtoe each, while the RE volume in Brazil grows from 58 to 91 Mtoe. This growth is achieved by a continued strong RE policy and is mainly due to installation of wind parks (Argentina, Brazil, Mexico), installation of small/medium hydro plants (Brazil) and an increase of the production of bio fuels (Argentina, Brazil).

Asia and Pacific (33 INCO countries)
Under both the reference and the maximum scenario, the RE volume in INCO Asia will surpass the RE volume in Latin America in 2020, because of the strong RE policies put in place, the strong growth in energy demand in these countries, and the dimension of these countries.

China and India have a large impact on the energy figures of INCO Asia; they account for ¾ of the TPES of the Asia INCO countries in the present situation as well as in 2020. The pressing need for reliability of supply and increase in capacity in order to keep up with fast paced economic growth in China and India provides the greatest incentive for these countries to implement sustainable RE policy measures. Volatile imported fuel costs also stimulate RE development. The incentives are undeniable and acknowledged. The RE percentage of the TPES grows in China and India to 2% under the 2020
reference scenario and to respectively 5 and 4% under the 2020 maximum scenario. Indonesia and Thailand also grow to these levels.

Under the reference scenario, the RE volume in the 33 countries in Asia and Pacific grows fivefold (from 21 at present to 101 Mtoe in 2020) while it grows tenfold (to 209 Mtoe) under the maximum scenario of sustained strong policy. The RE percentage of the TPES increases from 1% at present to 2% or 5% in 2020, in the reference and maximum scenario respectively.

Africa (48 INCO countries)
The present RE production in the African INCO countries, large hydro excluded, is marginal both in absolute figures (0.1 Mtoe) and in percentage of TPES (<0.1%). The reference and maximum scenarios show that RE production will remain marginal in African INCO countries in 2020, again both in volume and in percentage of TPES (respectively 1 and 3 Mtoe under the reference and maximum scenario, or 0.2 and 0.5% of the TPES).

Figure 1.3: RE volume in 114 INCO countries, large hydro excluded
Results for South Africa, the biggest RE contributor of the African INCO countries, show most important benefits from implementing measures towards the maximum scenario only (from 0.1 to 1.3 Mtoe). Its present position however, leads to modest progress in development in the reference scenario (from 0.1 to 0.3 Mtoe). Uganda shows promising results in the maximum scenario for RE electricity, large hydro excluded, 1 percentage point from the present situation. But this percentage is significantly lower in the reference scenario based on present policy.

These results highlight the critical need for RE development support from developed nations in the case of the poorest countries, especially for infrastructure, grid connections and market development. Climatic and political volatility, and economical instability provide stimulants and deterrents for the development of RE in Africa today.

1.3. At country level the RE market potential varies even more and is predominantly related to political will and finance availability for RE, except for the poorest countries, where providing access to energy primes

1.3.1. RE volumes and RE% of TPES
At present Brazil has the largest RE volume of the emerging and developing countries, especially due to its high use of biomass. China has the second largest volume, followed by Indonesia.

In the 2020 reference and maximum scenarios, Brazil and China still have the largest RE volumes but other countries also grow to substantial volumes, notably Argentina, Mexico, India, Indonesia and Thailand.

Brazil and the Pacific Islands have the highest RE percentage of TPES, 28% and 14% respectively in the present situation. The reference scenario shows that
present policy in both countries is not enough to maintain these high levels of RE% of TPES in 2020. The same effect but to a lesser extent is seen in other countries with significant present RE volumes, Argentina, Columbia, Mexico and Indonesia. Only with sustained strong policy the RE% of TPES can further grow in these countries, as the maximum scenario shows. In the Pacific Islands the RE% of TPES grows to 18% mainly as a result of the production of bio fuels from agro waste.

Figure 1.5: RE volume in 15 selected INCO countries, large hydro excluded

Figure 1.6: RE% of TPES in 15 selected INCO countries, large hydro excluded
1.3.2. RE% as a function of income per capita

Figure 1.7 demonstrates the RE% of TPES under the 2020 maximum scenario, as a function of the average income per capita of a country. The RE% of TPES remains at a very low level in the poorest countries: Niger, Uganda, Cameroon and Ghana. For the other countries the RE% grows to a level of 4 or 5% under the 2020 maximum scenario in which a strong RE policy is established.

There are however some noteworthy exceptions: the Pacific Islands and Brazil had very successful RE programmes in the past, and continued strong political will under the maximum scenario will ensure that a high RE% of TPES is maintained (even if a slight decrease seems inevitable). Argentina also grows to high levels under the maximum scenario, due to its robust RE policy, its favourable conditions for RE (especially for wind) and its success in reforming the energy sector so far. South Africa has a lower RE contribution than countries with a similar average income per capita; South Africa intends to have a more sustainable energy mix but it is used to cheap coal and it has significant reserves of fossil energy.

Figure 1.7: RE% of TPES for 15 INCO countries as a function of income/capita
Conclusions are similar if RE contribution is related to income per capita in the present situation or in the 2020 reference scenario. Conclusions are also similar if the RE contribution is related to the IEA’s Energy Development Index\(^2\), which is a composite measure of a country or region’s progress in its transition to modern fuels and of the degree of maturity of its energy end use.

**1.3.3. RE electricity as % of total electricity production can fivefold in 2020**

Eight out of the 15 countries studied have targets for RE electricity (Argentina, Brazil, Mexico, China, India, some Pacific Islands, Thailand and South Africa), either for the near future 2010-2012 or for the period 2020-2025. Most countries do not include large hydro in their target for RE electricity.

The present production of RE electricity will double under the reference scenario and will increase with more than a factor 5 under the maximum scenario.

Present RE percentage in electricity production is below 5% in all the countries, except in Uganda, where small hydro and waste are important electricity sources.

The growth of the RE electricity volume can under the reference scenario keep up with the growth in the electricity demand, except in Uganda and Indonesia, where small decreases are observed. The growth is generally achieved by an increase of small and medium hydropower, and to a lesser extent wind energy, biomass and agro waste. The variations between the countries in RE electricity percentage in the maximum scenario is much larger.

Potentials for more hydro, wind energy and (agro) waste treatment are important factors to achieve a higher percentage of electricity produced from renewables. However, most important to reach a high percentage is a pro-active energy policy that includes setting targets, providing possibilities to deliver to the grid, and regulations for good feed-in-tariffs for all independent producers. PV systems and mini and micro hydro only contribute a negligible part (<1 %) to the total electricity production, with the exception of some of the Pacific Islands. The percentages for the maximum scenario might be conservative, as for some countries there is no information available to assess RE production from biomass and (agro) waste. Most countries have a target between 10 and 25%.

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\(^2\) The IEA introduced an energy development index (EDI) in the 2004 edition of the World Energy Outlook to better understand the role that energy plays in human development. The EDI seeks to capture the quality of energy services as well as their quantity and can be used to assess the need for policies to promote the use of modern fuels and to stimulate investment in energy infrastructure in each region. It is calculated in such a way as to mirror the Human Development Index (HDI) of the United Nations Development Programme (UNDP).
Figure 1.8: RE-electricity as a % of total electricity production

Some countries include large hydro in their RE target. Large hydro accounts at present for over 75% of electricity production in some countries, such as Columbia, Peru, Cameroon, Ghana and Uganda. Countries which have not planned new large hydropower plants, or only a small number, see their RE% drop under the reference scenario, due to the increase in electricity demand. Under the maximum scenario this percentage can rise again due to an increased share of large hydro. Please note that only planned large hydro is included in RECIPES (see also paragraph 1.4).

Figure 1.9: large hydro-electricity as a % of total electricity production
### 1.3.4. Country descriptions

The table hereafter summarises the main outcome of the analysis of the 15 countries that were selected for the in-depth case studies. The full country reports including supporting annexes and documents are available at [www.energyrecipes.org](http://www.energyrecipes.org). The website also contains country briefs for all 114 INCO countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Characteristics, energy policy and drivers and barriers for RE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Argentina</strong></td>
<td><strong>Current situation:</strong> high income/capita ($12,400 in 2004). 40 million inhabitants. High EDI (0.7). 5% of population is not connected to an electricity grid. Net energy exporter with significant reserves of gas, oil and coal. 88% of TPES is from fossil sources, 4% from large hydro and 4% from renewable biomass.</td>
</tr>
<tr>
<td></td>
<td><strong>Energy and RE policy:</strong> robust energy policy. Competitive deregulated power sector. Several programmes for RE, target of 40% RE electricity in 2015. Target for bio fuel is under discussion.</td>
</tr>
<tr>
<td></td>
<td><strong>Barriers for RE:</strong> no integral, explicit and coordinated energy policy on RE. Low administrative level involved and low level of coordination. Low energy prices.</td>
</tr>
<tr>
<td></td>
<td><strong>Main possibilities:</strong> large potentials for large hydro, wind and bio fuel. Smaller potentials for PV, small hydro and solar thermal.</td>
</tr>
<tr>
<td></td>
<td><strong>Main steps forward:</strong> explicit RE policy under strong leadership, RE investment programmes, long-term perspectives for RE through tax incentives and reliable feed-in tariffs.</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td><strong>Current situation:</strong> high income/capita ($8,100 in 2004). 190 million inhabitants. High EDI (0.66). 4% of population is not connected to the grid. Significant reserves of gas, oil and coal. Imports 10% of its fossil energy (2003). RE (especially renewable biomass and bio fuels) forms 28% of TPES, large hydro 13%, and traditional biomass 4%.</td>
</tr>
<tr>
<td></td>
<td><strong>Energy and RE policy:</strong> robust energy policy, ambitious and successful RE policy. Several programmes for RE are in place.</td>
</tr>
<tr>
<td></td>
<td><strong>Barriers for RE:</strong> lack of finance availability and limited timeframe and scope of RE programmes are the main barriers for sustaining high RE levels.</td>
</tr>
<tr>
<td></td>
<td><strong>Main possibilities:</strong> large potentials for large hydro, small hydro, wind, bio fuel, biomass. Smaller potentials for PV and solar thermal.</td>
</tr>
<tr>
<td></td>
<td><strong>Main steps forward:</strong> adopting a continued strong RE policy beyond 2010, extending RE measures (e.g. feed-in tariffs) beyond current timeframe.</td>
</tr>
<tr>
<td>Country</td>
<td>Current situation: average income/capita ($6,600 in 2004). 43 million inhabitants. High EDI (0.61). 10% of population is not connected to the grid. Net energy exporter (oil and coal) with significant reserves of coal. RE forms 1% of TPES (although some calculations including bagasse come up with 6%), large hydro 12%, and traditional biomass 16%. Energy and RE policy: 2001 Law for the promotion of rational and efficient energy use, and alternative energy. 2003 decree for implementation. Some programmes with limited coverage. One RE target: 10% ethanol is mixed with gasoline in large cities in 2020. Barriers for RE: no RE targets, no plans or programmes with national coverage, no fixed feed-in tariff. Main possibilities: wind, bio fuel, biomass, small-medium and large hydro. Main steps forward: proactive energy and RE policy including targets and programmes. Specific programme for RE in rural areas.</td>
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<tr>
<td>Columbia</td>
<td>Mexico</td>
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<tr>
<td>Peru</td>
<td>Current situation: average income/capita ($5,600 in 2004). 30 million inhabitants. Average EDI (0.53). 24% of population is not grid connected. Produces its own oil and gas, and has significant reserves. RE forms 3% of TPES (RE biomass), large hydro 12%, and traditional biomass 18%. Energy and RE policy: written targets, plans or programmes exist for several RE technologies i.e. bio-diesel, ethanol, PV, small wind turbines, micro, mini and large hydro. Barriers for RE: lack of finance availability (concerning loans and investor opportunities). Short timeframe of policy measures (5 to 7 years). Lack of knowledge on RE. Energy prices lower than international market price. Main possibilities: small + large hydro, bio-fuels, wind, PV, solar thermal. Main steps forward: offering investment programs, increase timeframe of RE measures, increase end-use awareness, and improve training programs.</td>
</tr>
<tr>
<td>Country</td>
<td>Current situation: emerging super power with 1.3 billion inhabitants. Average income/capita ($5,600 in 2004). High EDI (0.60). Only 1% of population has no access to electricity. Producer of oil, gas and coal but has to import to catch up with demand. Significant fossil reserves. RE forms 1% of TPES (mainly small hydro), large hydro 2%, gas 2%, traditional biomass 8%, oil 22% and coal 64%.</td>
</tr>
<tr>
<td>印度</td>
<td>Current situation: average income/capita ($3,100 in 2004). 1.1 billion inhabitants. Low EDI (0.33). 54% of population has no access to electricity. Producer of oil, gas and coal but has to import to catch up with demand. Significant fossil reserves. RE forms 0.3% of TPES, large hydro 1%, gas 5%, oil 20%, traditional biomass 33% and coal 41%. Ranks in top-5 worldwide for installed wind and PV capacities. Energy and RE policy: target of 10% RE of additional electricity capacity. Several programmes directed to biomass, rural energy, solar water heating, PV, energy recovery for wastes. Fiscal incentives, subsidies and soft loan programmes are in place. Several specific targets for 2007: wind +1,500 MW, biomass +750 MW, small hydro +600 MW, and PV +2 MW. Barriers for RE: lack of national RE policy, top-down approach leads to disconnection with reality and consumer needs, lack of RE awareness in energy sector and parts of government, predominant attention for grid technologies while non grid technologies fit very well with rural areas. Main possibilities: large and small hydro, wind, biomass, ethanol, and to a lesser extent: PV, solar thermal and bio diesel. Main steps forward: adopt national RE policy. More involvement of manufacturers, NGOs and consumers in RE programs, increase awareness for RE in energy sector and parts of government.</td>
</tr>
</tbody>
</table>
### Indonesia

**Current situation:** average income/capita ($3,500 in 2004). 242 million inhabitants. Average EDI (0.41). 20% of villages have no access to electricity. OPEC member but importing oil since 2004. Exporter of gas and coal with high reserves. RE forms 2% of TPES (geothermal and biomass), large hydro 0-1%, traditional biomass 32% and fossil 65%.

**Energy and RE policy:** RE target of 13.3% of TPES in 2025. Specific targets for geothermal, bio fuels and large hydro. Laws for electricity, oil and gas, and geothermal. New regulation on non-traditional biomass but environmental impact is disputed. Focus of rural electrification program is on grid extension and diesel generators; target is 10% RE.

**Barriers for RE:** no robust conditions for RE investment, high uncertainty for RE investors, low energy prices, price negation system with distribution monopoly for selling electricity to the grid.

**Main possibilities:** geothermal, large hydro, solar thermal, bio fuels, and to a lesser extent: PV, wind, and small hydro. Biomass and waste unclear.

**Main steps forward:** extent energy legislation with laws on RE and so provide certainties for investors. Robust and fixed feed-in tariff. Avoid that biomass projects (i.e. palm oil) have high local environmental impact.

### Pacific Islands (Fiji Islands, Vanuatu, Kiribati)

**Current situation:** income/capita varies per country: average in Fiji ($5,900 in 2004), low in Vanuatu ($2,900) and very low in Kiribati ($800). Fiji has 0.9 million inhabitants, Vanuatu 0.2 million, Kiribati 0.1 million. Only the EDI of Kiribati is know and is very low (0.12). Grid connection varies from 60% in Fiji to 19% in Vanuatu. Due to RE biomass and hydro, RE% of TPES is high in all countries: 27% in Fiji, 21% in Vanuatu and 33% in Kiribati. Traditional biomass varies from 23% in Kiribati to 40% in Vanuatu, the rest of TPES is oil and gas that are entirely imported.

**Energy and RE policy:** access to energy is a major concern in all countries; all have some plans and structure for RE; all have experience with PV in rural areas. Fiji has an unofficial target of 80% electricity by RE and large hydro. Vanuatu will double the capacity of its hydro plant.

**Barriers for RE:** lack of finance availability for RE, lack of structure and skills to implement new RE technologies such as wind and small hydro.

**Main possibilities:** hydro, wind and RE biomass, to a lesser extent PV.

**Main steps forward:** for the 3 countries this varies but includes good RE regulations, governmental founded organisations with budget and authority in RE, improving finance availability by access to international finance mechanisms and offering good conditions for private investors.
<table>
<thead>
<tr>
<th>Country</th>
<th>Current situation: high income/capita ($8,100 in 2004). 65 million inhabitants. High EDI (0.68). Only 1% of population is not grid connected. Most fossil fuels are imported although Thailand has reserves of natural gas. RE is only 0.1% of TPES, large hydro 1%, traditional biomass 15%, and fossil fuels 84%.</th>
<th>Energy and RE policy: ambitious RE policy aiming to reduce oil dependency. RE target is 8% of TPES in 2011, large hydro excluded. From 2008 power companies are required to install 3 to 5% RE capacity of any new conventional power plant (RPS). Furthermore targets per RE technology: PV 250 MW, wind 100 MW, urban waste 100 MW, hydro 350 MW, biomass plants 1,040 MW, ethanol 5-10%, bio diesel 5-10%.</th>
<th>Barriers for RE: high implementation costs of reaching the set RE targets; artificially low oil prices; availability of biomass; competition with food sector; monopolistic position of power distribution and production</th>
<th>Main possibilities: bio fuels, biomass/waste treatment. To a lesser extent small hydro, PV, wind, solar thermal. Main steps forward: adopt implementing fiscal and legislative measures to provide stability to RE investors. Correct artificially low oil prices. Establish a regulatory authority for implementing RPS. Remove barriers to deliver to the grid. Reduce administrative burden for RE industry.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroon</td>
<td>Current situation: low income/capita ($1,900 in 2004). 16 million inhabitants. EDI is average (0.41). 60% of population is not connected to an electricity grid. 70% of energy consumption comes from traditional biomass. &gt;95% of electricity is produced by medium and large hydropower. Oil exporting country.</td>
<td>Energy and RE policy: focus so far is on development of hydro electricity but a new integral energy plan is in the planning process. The new energy fund of the Rural Electrification Agency might enhance RE.</td>
<td>Barriers for RE: lack of foreign investment, high import taxes, negative attitude of population due to lack of successful RE projects.</td>
<td>Main possibilities for RE: hydro, PV, RE biomass and waste. Main steps forward: promotion of RE through successful RE projects, attracting foreign investors in RE (e.g. by combining with the exploitation of gas reserves), support local RE industry.</td>
</tr>
<tr>
<td>Ghana</td>
<td>Current situation: low income/capita ($2,300 in 2004). 21 million inhabitants. EDI is low (0.30). 55% of population is not connected to an electricity grid. 60% of energy consumption comes from traditional biomass. 85% of electricity is produced by hydropower. All fossil fuel is imported.</td>
<td>Energy and RE policy: a national energy plan 2006-2020 is drafted. Main issues are energy efficiency, electrification, elimination of power shortage and liberalisation. Intention: fulfil 10% of energy need with hydro or RE.</td>
<td>Barriers for RE: lack of comprehensiveness of energy policy and financial schemes, no possibility to deliver electricity to the grid.</td>
<td>Main possibilities for RE: hydro, PV, RE biomass and waste. Main steps forward: promotion of RE through successful RE projects, consistent policy including opening the grid, further and consistent support of RE equipment.</td>
</tr>
<tr>
<td>Country</td>
<td>Current situation: very low income/capita ($900 in 2004). 11 million inhabitants. EDI is unknown but low. 93% of population is not connected to an electricity grid. &gt;85% of energy consumption comes from traditional biomass. 55% of electricity is imported; all fossil fuel is imported.</td>
<td>Energy and RE policy: energy policy and poverty reduction strategy. Focus on access to energy, energy independency, environmental protection and RE. Electricity sector reform ongoing to encourage private investors. RE target including large hydro is 10% for 2020. Three large hydro plants (250 MW) are planned, one of them for 2012 (125 MW).</td>
<td>Barriers for RE: RE does not have a positive image, high fiscal charges, lack of finance availability for RE with high initial investment cost.</td>
<td>Main possibilities: hydro (large and small), biomass, PV</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Niger</td>
<td>Current situation: one of the richest EDCs. High income/capita ($11,100 in 2004). 44 million inhabitants. High EDI (0.6). 34% of population is not connected to an electricity grid. 9% of energy consumption comes from traditional biomass, 80% from coal. Significant reserves of coal.</td>
<td>Energy and RE policy: robust energy policy. Focus on a more sustainable energy mix, and on electrification in rural areas. Since 2003 a RE policy exists. RE target is 1% extra RE in 2013 (compared with current TPES).</td>
<td>Barriers for RE: RE target too low to be stimulating, cheap electricity and coal, lack of clarity on RE policy, discussion about focus on large or small RE projects, image of RE as second best, at present not being in scope of international finance mechanisms (CDM) that focus on large projects.</td>
<td>Main possibilities: large potentials for small hydro, wind and bio fuel. Smaller potentials for PV, geothermal and solar thermal.</td>
</tr>
<tr>
<td>South Africa</td>
<td>Current situation: very low income/capita ($1,500 in 2004). 27 million inhabitants. EDI unknown but low. 95% of population is not connected to an electricity grid. 90% of energy consumption comes from traditional biomass. All fossil fuel is imported.</td>
<td>Energy and RE policy: focus on electrification, efficient use of traditional biomass, and access to modern energy in rural areas. Three large hydro plants planned. No RE target. Government supports local RE industry.</td>
<td>Barriers for RE: main problems are lack of finance availability and limited interest of potential investors.</td>
<td>Main possibilities for RE: mainly in small RE systems: mini/micro hydro, PV, bio-energy installations for agro industry.</td>
</tr>
</tbody>
</table>
1.3.5. RE issues from the country studies

The following issues have come up during the RECIPES project as points of discussion with regard to drivers, barriers, technologies and the implementation of renewable energy:

a. **Focus is on RE electricity while there’s much to win with bio energy.** In studies, literature and policies, a lot of attention is being given to production of electricity from renewable sources compared to other forms of energy demand. Although for rural areas that are not connected to the grid, electrification is an important step in the development, it appears that other applications are neglected. This may change however in the near future; with the growing attention for bio fuels and energy from waste becoming a serious option.

b. **Small and large systems are different worlds and require different instruments.** A market driven approach and a mandatory RE target leads to larger projects and the implementation of larger systems in a market that is already relatively successful. Little attention is given to the poorest or thinly populated regions that may require smaller systems and involve complex organisation aspects; as a result these regions lag behind. In some countries this is at present an urgent issue because the administration needed for being a CDM project can only be justified for large projects (e.g. a wind park versus wind turbines scattered over the land)

c. **Lack of finance availability can relate to lack of money or lack of certainty.** Lack of finance is often mentioned as a barrier in this study, but this general term can stand for quite different types of barriers for the various technologies. For small projects it can refer to the problems for consumers who can’t afford the investment or bank regulations / investment policies that are not adequate for RE projects. For larger systems it can reflect on the long return on investment period or on unreliable energy policies, which cause a reluctant attitude among investors.

d. **Sharing of knowledge and experiences is not sufficiently addressed at the moment.** Many countries are aiming to increase the size of their projects, from demonstration scale to full-scale programmes (other than the well known small home systems). This implies that a more long-term organisational approach is needed with adequate resources for maintenance and follow-up. On the other hand there is also a clear indication that there is a need for more country-, region- or technology specific R&D. For both approaches, the sharing of knowledge and experiences is seen as a key factor that is not sufficiently addressed at the moment. There are few incentives for private companies to share their RE technology. Access to information on RE technologies is difficult in EDCs.

e. **Liberalisation of the energy market does not have a direct influence on RE.** Liberalisation is often mentioned in combination with an open electricity market and good feed-in tariffs. However, making laws and long-term regulations does not depend on the owner structure of the energy market but on the will and possibilities to make these laws and regulations.

f. **Fulfilling the energy demand is key.** Small systems like solar home systems that do not produce enough energy to fulfil a near future demand or do not provide enough possibilities for further economic development can
negatively influence the attitude towards renewable energy. In order to cope with this, it may be advisable that implementation programmes can be flexible and offer different (sized) options for the various regions in a country.

g. **RE should fit into every country’s specific situation and policy.** If RE fulfils a country’s needs, it is likely to be a sustainable solution. If RE is pushed, e.g. in hardware development projects, without a clear fit with its energy policy, it is in most cases not sustainable and not successful.

h. **Lack of continuous energy supply:** energy supply intermittence may require the combination with another energy source in a hybrid system to guarantee continuous supply. This affects particularly wind and solar, but also hydro more and more;

i. **Institutional and administrative difficulties.** RE is a government driven business, therefore the quality of the country’s institutions is key to success;

j. **Hard currency expenditure:** some RE technologies require high levels of automation which implies more importation of goods and more hard currency expenditures;

k. **Special measures are required for poor and smaller countries.** The bigger and more developed countries have tempting markets for investors in RE. Attention should be paid to smaller and less-developed countries. They have difficulty profiting from international finance mechanisms that have been put in place and are unable to compete on the technology learning curve.
1.4. Large hydro is disputed as RE technology but considered RE in many countries and accounts for 2 to 3% of TPES

Large hydro is an important energy technology in emerging and developing countries and a zero-carbon energy technology. Many countries include large hydro as RE in their national energy balances. At the same time, however, large hydro is disputed as RE technology, because of its significant environmental and social impacts.

In order to be able to present comparable figures, and to take account of the disputed status of large hydro as RE technology, we decided to give large hydro a ‘status aparte’ in the RECIPES project. We collected information on the present situation of large hydro in the 15 selected countries. We furthermore collected information on planned large hydro plants and included these plants in the ‘reference scenario’. The ‘maximum scenario’ in addition includes ambitions for new large hydro; in most cases this concerns large hydro plants for which an exact time frame is not yet available or the investment is not yet secured. From the 15 countries we then extrapolated to the 114 countries as we did for RE technologies.

The figures 1.10 and 1.11 show the results of this analysis at the level of the 114 emerging and developing countries. Under the ‘reference scenario’, the present energy production from large hydro in the 114 INCO countries will grow with a factor 1.6 in 2020, from 89 to 144 Mtoe. TPES will grow with a similar factor (1.7) in the 114 countries. Under the reference scenario the contribution of large hydro to TPES therefore remains stable at 2%.

Under the ‘maximum scenario’ a further increase of energy production from large hydro is foreseen in 2020, to 202 Mtoe. In this case the contribution of large hydro to TPES will grow to 3% and thus grows at a more rapid pace than TPES.

\[\text{Note that the scenarios in the case of large hydro were not based on specific drivers and barriers as were the scenarios for RE technologies, and that large hydro was not studied in the same level of detail. As the main focus was on ‘undisputed’ RE technologies, this does not compromise the results and outcome of the RECIPES project in our view. However, not using drivers and barriers might mean that the maximum scenario for large hydro is conservative since we took account of plants foreseen at present, while, especially in the period 2015-2020, new plants can be added to this and may be operational in 2020.}\]
Figure 1.10: RE and large hydro volumes in 114 INCO countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Large hydro</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>89 Mtoe</td>
<td>95 Mtoe</td>
</tr>
<tr>
<td>2020 ref scenario</td>
<td>144 Mtoe</td>
<td>182 Mtoe</td>
</tr>
<tr>
<td>2020 max scenario</td>
<td>202 Mtoe</td>
<td>345 Mtoe</td>
</tr>
</tbody>
</table>

Figure 1.11: RE and large hydro as part of TPES in 114 INCO countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Large hydro</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>2.5%</td>
<td>2.6%</td>
</tr>
<tr>
<td>2020 ref scenario</td>
<td>2.4%</td>
<td>3.0%</td>
</tr>
<tr>
<td>2020 max scenario</td>
<td>3.4%</td>
<td>5.9%</td>
</tr>
</tbody>
</table>

At present Brazil and China have the largest volumes of large hydro in the emerging and developing countries, respectively 26 and 24 Mtoe, followed by India with 6 Mtoe. The definition of large hydro varies in the countries (between 5 and 50 MW as the lowest boundary). We have respected the boundaries that are used in the various countries and thus also have used varying boundaries.

The reference scenario includes planned large hydro plants for which decision-making is finalised. Such plants exist in all countries except Argentina, Ghana and South Africa. In 2020 these new plants will account for an energy production of 27 Mtoe in China, 6 Mtoe in India, 4 Mtoe in Brazil, 2 Mtoe in Indonesia and <1 Mtoe in other countries, in total 42 Mtoe.
In the **maximum scenario** this grows, due to targeted plants, with a further 28 Mtoe in China, 10 Mtoe in India, 4 Mtoe in Indonesia and <1 Mtoe in Cameroon, Ghana, Niger and Uganda, in total another 42 Mtoe.

In the Latin-American countries Brazil, Colombia and Peru, large hydro forms the highest percentage of TPES: 12 and 13%. This percentage will drop in 2020 since the total capacity of new large hydro plants is not sufficient to keep pace with the increase in TPES. The environmental and social impact of large hydro refrains these countries from increases higher than accepted and planned, although the natural potential for large hydro is still abundant. Some countries with high contributions of large hydro in their total electricity production (like Brazil) strive for a diversification of their sources to secure their electricity delivery and to become less dependent on rainfall.

All Asian and African countries plan significant investments in large hydro, except South Africa. Under the 2020 reference scenario, seven out of ten Asian and African countries observe that large hydro grows at a higher pace than TPES. These countries try to mitigate the environmental and social impacts of large hydro but consider that large hydro is crucial for their national energy balance and decided to invest in it, and to integrate large hydro into their water management.

*Figure 1.12: large hydro volume in 15 INCO countries*
Figure 1.13: large hydro as % of TPES in 15 INCO countries
1.5. Other studies are in line with RECIPES although the range of uncertainty is high

We have compared the outcome of the technical and market potential analysis carried out in the RECIPES project with existing studies.

The analysis of these studies showed the added-value brought by the RECIPES project: there are no existing studies providing information with such a level of detail at a country level given by local experts, in terms of data for all RE market and technology combinations, but also in terms of RE market analysis, and (renewable) energy policies.

Local experts also gave their opinion on the outcome of the RECIPES scenarios, which provide RE market potentials in 2020.

The most significant studies with similarities with the RECIPES assessment of market potentials in 2020 are:
- US DoE Energy Information Administration – EIA scenarios
- WEC – World Energy Council – scenarios to 2050
- Shell scenarios to 2050
- EREC scenarios to 2040
- Wind Force12 - Greenpeace and EWEA
- UNDP/GEF – Global Environment Facility

The first two studies (US EIA and IEA figures) had sufficient similarities in geographical scope, timescale and market scope to make a comparison possible with the RECIPES figures for the present situation. For the 2020 outlook only the US EIA figures could be used for comparison.

For the comparison of the present situation, shown in Table 1.1, the conclusions are as follows:
1. For large hydro similarity is very high: discrepancies between the three sources (RECIPES, IEA and EIA) for the present electricity production from large hydro are very limited.
2. For RE electricity from sources other than large hydro, similarity is high but there are some noteworthy differences which can be explained easily: the following differences can be observed in RE electricity from other sources than large hydro:
   - RE electricity figures for RECIPES are higher than IEA and EIA figures in all countries except Indonesia and Thailand. This is because RECIPES only excludes large hydro, whereas IEA and EIA exclude all hydro. The difference is pretty much the value for small hydro.
   - RE electricity value for RECIPES in China is much higher. A major difference is observed in China: RECIPES has 104.9 TWh for RE electricity while excluding large hydro, whereas IEA and EIA have respectively 2.5 TWh and 2.3 TWh. This difference is for the largest part also explained by the aforementioned reason (small hydro accounts
for 93 TWh). The remaining difference comes from geothermal power: there is a production of 10 TWh/year from geothermal in China; this has not been included in the IEA figure.

3. **For RE used for other purposes than electricity, RECIPES figures are higher due to a definition issue.** The RECIPES figures for RE used for other purposes than electricity, are much higher than the IEA figures, while EIA does not have figures for this. This difference is explained because non-traditional use of biomass for other purposes than electricity (RE heat from biomass) is not included in the IEA figures.

Table 1.1: present RE volumes RECIPES compared to IEA and EIA

<table>
<thead>
<tr>
<th>Present RE contribution</th>
<th>Present - RECIPES</th>
<th>Present - IEA</th>
<th>Present EIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total primary energy Mtoe</td>
<td>Renewable total</td>
<td>Renewable electricity</td>
</tr>
<tr>
<td></td>
<td>excl. large hydro Mtoe</td>
<td>excl. large hydro Mtoe</td>
<td>excl. large hydro TWh</td>
</tr>
<tr>
<td>Argentina 69</td>
<td>64 36 538.6 1.3</td>
<td>80.1 35.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Brazil 207</td>
<td>94 58 523.7 22.2</td>
<td>32.1 519.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Colombia 28</td>
<td>4 0.2 40.0 1.7</td>
<td>3.16 0.05</td>
<td>36.7 0.5</td>
</tr>
<tr>
<td>Mexico 163</td>
<td>5 3 51.5 6.6</td>
<td>2.59 0.02</td>
<td>52.7 0.8</td>
</tr>
<tr>
<td>Russia 52</td>
<td>1.9 0.4 18.9 0.8</td>
<td>1.97 0.07</td>
<td>18.7 0.2</td>
</tr>
<tr>
<td>China 130</td>
<td>37 13 304.9 10.4</td>
<td>25.87 1.48</td>
<td>286.2 2.5</td>
</tr>
<tr>
<td>Pacific 0.6</td>
<td>0.2 0.1 9.5 0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>India 578</td>
<td>8 2 89.0 19.4</td>
<td>6.95 0.47</td>
<td>80.9 5.5</td>
</tr>
<tr>
<td>Indonesia 162</td>
<td>5 4 13.8 3.6</td>
<td>1.32 0.54</td>
<td>15.4 6.3</td>
</tr>
<tr>
<td>Thailand 52</td>
<td>9 0.7 17.0 0.0</td>
<td>0.86 0.43</td>
<td>9.9 2.6</td>
</tr>
<tr>
<td>Cameroon 7</td>
<td>0.3 0.0 3.6 0.0</td>
<td>0.3 0.0</td>
<td>3.3 0.0</td>
</tr>
<tr>
<td>Central Africa 9</td>
<td>0.5 0.0 5.3 0.0</td>
<td>0.03 0.0</td>
<td>5.9 0.0</td>
</tr>
<tr>
<td>Niger 2</td>
<td>0.0 0.0 9.0 0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>South Africa 112</td>
<td>0.2 0.1 2.2 0.5</td>
<td>0.35 0.02</td>
<td>4.1 0.3</td>
</tr>
<tr>
<td>Uganda 9</td>
<td>0.1 0.0 1.2 0.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15 countries 2796</td>
<td>151.7 93.5 954.4 161.2</td>
<td>75.52 9.04</td>
<td>541.7 40.7</td>
</tr>
<tr>
<td>Latin America 479</td>
<td>100.1 64.5 447.0 32.7</td>
<td>42.53 6.9</td>
<td>437.9 23.5</td>
</tr>
<tr>
<td>Asia 2177</td>
<td>90.5 18.9 495.2 127.9</td>
<td>35.00 2.72</td>
<td>392.8 16.9</td>
</tr>
<tr>
<td>Africa 138</td>
<td>41.1 0.1 12.3 0.6</td>
<td>0.99 0.02</td>
<td>11.5 0.3</td>
</tr>
</tbody>
</table>

For the comparison of the scenarios for 2020, a comparison was possible for two factors: (i) TPES excluding traditional biomass and (ii) total electricity from RE including large hydro.

Prior to any comparison, one should take the following remarks into consideration:

1. **EIA and RECIPES models do not have the same approach.** EIA extrapolations are mainly based on growth of GDP and energy demand. RECIPES also takes the demand into account, but in its maximum scenario, it looks for drivers, which might privilege RE versus conventional energy.

2. **Reference scenario:** EIA and RECIPES reference scenarios extrapolate a continuation of the present situation, in terms of energy growth and in terms of present policies. But RECIPES emphasises the importance of the present RE policy, whereas the EIA’s reference scenario is mainly based on the expected energy demand growth.

3. **Maximum scenario:** There is a noteworthy difference between the 2 maximum scenarios: EIA assessed a maximum energy demand (and RE
demand) growth, whereas RECIPES assessed the maximum RE share in the overall energy demand. Therefore, the TPES in RECIPES maximum scenario is not the maximum TPES, but the TPES we would obtain with a maximum RE production.

The table below shows the main outcomes; the main conclusions are as follows:

1. **The 2020 figures for the 114 INCO countries show a high similarity.** Both the TPES in 2020 excluding traditional biomass, and the total electricity from RE including large hydro in 2020 are similar. The RECIPES estimates show a wider range (from 2,000 to 3,600 TWh) in the RE contribution to electricity production than the EIA figures (from 2,200 to 2,700 TWh). This wider range is mainly explained by the difference of methodology explained in point 1 of the previous paragraph: the two RECIPES scenarios accentuate the importance of RE policies, and acting on drivers and barriers, which might result in a larger scope of RE market potentials.

2. **There is a high similarity for the TPES for Asia and limited discrepancies for Latin America and Africa.** In the case of Asia the RECIPES figures are between the low and high growth scenarios of EIA. The RECIPES figure for TPES is 15% higher for Latin America, and about the same for Africa, which appears to be reasonable given the timescale and the differences of approach chosen by RECIPES and EIA.

3. **At country level there are limited differences in the 2020 estimates for the TPES, except for Brazil.** This particular result for Brazil (nearly 50% discrepancy) was thoroughly analysed. It is partially explained by differences in present situation (20%), and by a higher growth rate for RECIPES (30%). RECIPES nevertheless confirms its figures, which are corroborated by official Brazilian figures.

4. **The figures for 2020 for RE electricity show rather large discrepancies (30% and beyond) but this is acceptable given the differences of approach and uncertainties of long-term scenario.**
   a. **At a country level:** EIA figures in 2020 are higher for Brazil and Mexico. RECIPES figures are higher for China and India. Asia figures are similar but the upper range of the RECIPES scenario is much higher. These differences are in our view related to the difference in methodology, and to the high importance of drivers of barriers in the RECIPES scenarios, which might lead to higher RE growth as explained in point 1 above. In the Chinese case, which shows the most striking discrepancy, it should be noted that RECIPES figures seem optimistic, but are still much below the Chinese governments targets.
   b. **At a continent level:** the comparison is indicative in this case. As EIA doesn’t provide information about total RE production, RECIPES extrapolated RE electricity production for the 5 studied countries to the entire continent to get a view on total RE electricity production.

5. **Comparison is altered for Africa because of Maghreb countries and extrapolation method used for this comparison.** In Africa, the comparison is altered because the EIA figures include all African countries, whereas RECIPES figures exclude Maghreb (Algeria, Egypt, Libya, Morocco, Tunisia), and Reunion and Saint Helena. We assessed that the share of RE
electricity from Maghreb was about 25% of Africa’s RE production in 2003, and would be about 30% in 2020 because these countries are amongst the richest and most rapidly developing African countries. The 2020 RECIPES figures are significantly higher than EIA. This comparison must be interpreted very cautiously as RECIPES extrapolated results for the 5 studied countries to Africa to get RE electricity production (RECIPES calculated RE production for Africa, so this extrapolation is only used for the present comparison). The degree of uncertainty is high given the fact that the 5 countries only represent 10% of Africa’s RE production, Maghreb included.

The overall conclusion of the comparison is that the RECIPES estimates are in line with other studies although the range of uncertainty is high and significant differences occur, especially at country level. These differences were anticipated and might be considered rather limited given the high level of uncertainties for such long-term projections, and the difference of approach between the EIA model and the RECIPES model.

For the full comparison we refer to the deliverable ‘Comparison of RECIPES results with results of other projects/initiatives/studies’ that is available on www.energyrecipes.org.
2. An increased volume of renewable energy has a positive socio-economic impact in emerging and developing countries

Part of the research of the RECIPES project was directed towards assessing the socio-economic and environmental impact of renewable energy technologies in emerging and developing countries. Three activities were undertaken for this purpose:

a. A survey on socio-economic and environmental effects. A survey was carried out among 123 experts in emerging and developing countries regarding the socio-economic and environmental effects of renewable energy technologies in these countries;

b. Estimation of the CO₂ emission reduction potential. Based upon the market potential for renewable energy of the 15 emerging and developing countries that were studied, the potential for CO₂ emission reduction was estimated;

c. A comparison with other studies. The results of the survey and the calculations were compared with other research regarding socio-economic and environmental effects of renewable energy in emerging and developing countries.

The research shows that renewable energy clearly has positive socio-economic and environmental effects in emerging and developing countries. Why? Four reasons:

a. Experts indicate that renewable energy technologies contribute more to socio-economic development in emerging and developing countries than non renewable energy technologies;

b. Solar, hydro, bio-energy and wind technologies reportedly contribute most, fossil based and nuclear technologies least;

c. Renewable energy technologies have a significant CO₂ reduction potential;

d. Other studies confirm these results.

These reasons are developed more in detail in the following paragraphs. For the full results of the socio-economic analysis we refer to the socio-economic report and its annexes that are available on www.energyrecipes.org.

2.1. Experts indicate that RE technologies contribute more to socio-economic development in emerging and developing countries, than non RE technologies;

In the survey, 318 experts from all over the world, whom we considered having a good understanding of the socio-economic effects of energy technologies in emerging and developing countries, were asked to fill in 16 questions regarding the social, economic and environmental aspects of (renewable) energy technologies in these countries. In total 123 experts responded, of which 97 filled in the survey substantially. We have mainly used these 97 responses for our analysis.
The experts were asked to assess 10 types of socio-economic effects in emerging and developing countries, in relation to the implementation of 8 different energy technologies. The 10 aspects are considered to cover the key socio-economic effects in emerging and developing countries:

β The first 7 aspects (see table 2.1) were derived from the UN Millennium project and related to energy technologies;

β The 8th aspect ‘Country trade balance’ has become increasingly important given the high oil prices in recent years, especially for countries with a negative trade balance and high dependency on fossil fuels for their energy supply;

β The 9th aspect ‘Security of supply’ always has been an important factor for energy technologies or fuels and is nowadays related to the political and economic instability in important energy (oil) supplying countries, and the threat of terrorism;

β The 10th and last aspect ‘Energy costs’ is an obvious and key aspect for energy technologies, both for decision makers and for end consumers.

Figure 2.1 presents the overall score per energy technology. Respondents clearly expressed that renewable energy technologies have a more positive socio-economic impact\(^4\) on emerging and developing countries than non-renewable energy technologies.

*Figure 2.1 Overall socio-economic score per energy technology*

\(^4\) Experts were requested to indicate the ‘relative’ impact of energy technologies, by answering the following question: “Assuming that energy technologies will be implemented to the same extent (in MW, Mtoe or kWh), what will be their effect on socio-economic aspect \(X\)”? By asking experts to indicate a relative impact it was avoided that impact potential and implementation potential were mixed. Answers were technology related instead of country related or potential related.
2.2. Solar, hydro, bio-energy and wind technologies reportedly contribute most, fossil based and nuclear technologies least

Table 2.1 presents the scores per socio-economic aspect and also highlights which technology scored best, 2nd best or worst per aspect.

Solar and hydro are considered to contribute most to the socio-economic development in emerging and developing countries: for nine out of ten aspects these RE technologies obtain the best scores. Hydro and wind follow closely. Fossil fuel based and nuclear energy technologies are considered to contribute least to the socio-economic development in emerging and developing countries: either fossil fuel or nuclear received the worst score on each of the 10 aspects.

Geothermal received relatively low socio-economic scores; the data did not permit us to fully comprehend why, but we consider that this is partly because the technology is not very well known among all the experts that participated in the survey, as this RE technology is not present in all countries and only a few installations are installed and operational.

Traditional biomass is considered to have a lower socio-economic impact than RE technologies, especially regarding indoor air pollution, conditions for education and gender equality. This is in line with other publications on the subject (see section 2.4).

Table 2.1 Overall (relative) scores of the survey

<table>
<thead>
<tr>
<th>Energy technologies</th>
<th>Bio-energy</th>
<th>Fossil based</th>
<th>Geothermal</th>
<th>Hydro</th>
<th>Nuclear</th>
<th>Solar</th>
<th>Traditional biomass</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>National job creation</td>
<td>0,83</td>
<td>0,35</td>
<td>0,36</td>
<td>0,75</td>
<td>-0,06</td>
<td>0,77</td>
<td>0,49</td>
<td>0,64</td>
</tr>
<tr>
<td>Agricultural activities</td>
<td>0,87</td>
<td>0,33</td>
<td>0,22</td>
<td>0,71</td>
<td>0,00</td>
<td>0,73</td>
<td>0,43</td>
<td>0,58</td>
</tr>
<tr>
<td>Safe cooking of food</td>
<td>0,75</td>
<td>0,38</td>
<td>0,21</td>
<td>0,41</td>
<td>0,00</td>
<td>0,69</td>
<td>0,30</td>
<td>0,27</td>
</tr>
<tr>
<td>Conditions for education</td>
<td>0,68</td>
<td>0,33</td>
<td>0,41</td>
<td>0,75</td>
<td>0,00</td>
<td>0,88</td>
<td>0,07</td>
<td>0,68</td>
</tr>
<tr>
<td>Gender equality</td>
<td>0,73</td>
<td>0,35</td>
<td>0,32</td>
<td>0,63</td>
<td>0,00</td>
<td>-0,77</td>
<td>0,04</td>
<td>0,53</td>
</tr>
<tr>
<td>Indoor air pollution</td>
<td>0,66</td>
<td>-0,16</td>
<td>0,46</td>
<td>0,61</td>
<td>0,00</td>
<td>-0,82</td>
<td>-0,14</td>
<td>0,57</td>
</tr>
<tr>
<td>Loss environmental resources</td>
<td>0,29</td>
<td>-0,05</td>
<td>0,59</td>
<td>0,58</td>
<td>-0,21</td>
<td>-0,88</td>
<td>0,19</td>
<td>0,71</td>
</tr>
<tr>
<td>Country trade balance</td>
<td>0,81</td>
<td>-0,15</td>
<td>0,45</td>
<td>0,73</td>
<td>0,03</td>
<td>0,68</td>
<td>0,28</td>
<td>0,64</td>
</tr>
<tr>
<td>Energy security</td>
<td>0,83</td>
<td>-0,05</td>
<td>0,62</td>
<td>0,72</td>
<td>0,02</td>
<td>0,83</td>
<td>0,37</td>
<td>0,78</td>
</tr>
<tr>
<td>Energy costs</td>
<td>0,24</td>
<td>-0,45</td>
<td>-0,14</td>
<td>0,22</td>
<td>-0,34</td>
<td>-0,16</td>
<td>0,25</td>
<td>-0,01</td>
</tr>
<tr>
<td>Overall score</td>
<td>6,70</td>
<td>0,87</td>
<td>3,51</td>
<td>6,11</td>
<td>-0,57</td>
<td>6,90</td>
<td>2,27</td>
<td>5,39</td>
</tr>
</tbody>
</table>
Conclusions per socio-economic aspect are as follows:

1. **National job creation.** Bio, solar and hydro energy technologies are considered to stimulate national job creation in emerging and developing countries the most, nuclear technologies the least;
2. **Agricultural activities.** RE bio-energy is considered to have the best (relative) potential to stimulate agricultural activities, followed by solar and hydro energy technologies;
3. **Safe cooking of food.** RE bio-energy and solar energy have the best (relative) potential to improve the safe cooking of food; other technologies stay far behind;
4. **Conditions for education.** Solar has the best (relative) potential to improve conditions for education; hydro, wind and bio energy follow closely;
5. **Gender equality.** Solar and bio have the best (relative) potential to improve gender equality; bio and hydro energy follow closely;
6. **In door air pollution.** Solar has the best (relative) potential to reduce indoor air pollution; bio, hydro and wind energy follow at a distance;
7. **Loss of environmental resources.** Solar is considered to have the best (relative) potential to reduce the loss of environmental resources; wind, bio and hydro energy follow at a distance.
8. **Trade balance.** RE bio-energy has the best (relative) potential to improve the trade balance; closely followed by hydro, solar and wind; fossil fuel based and nuclear technologies the least;
9. **Energy security.** Solar, bio, wind and hydro are considered to have the best (relative) potential to improve energy security; fossil fuel based and nuclear technologies the least;
10. **Energy costs.** Traditional biomass, bio-energy and hydro are considered to be the cheapest energy technologies; fossil fuel based and nuclear technologies the most expensive ones.

2.3. **RE technologies have a significant CO₂ reduction potential**

An additional and obvious advantage of RE technologies is the reduction of carbon dioxide emissions, when compared with fossil fuel based technologies.

Under the maximum scenario, replacement of non-renewable energy technologies with renewable energy technologies leads to a CO₂ emission reduction of 620 Mton CO₂ per annum in the 15 emerging and developing countries in 2020. If the present capacity of renewable energy installations is added, the overall CO₂ emission reduction is 950 Mton CO₂ per annum in the 15 emerging and developing countries in 2020.

The CO₂ reduction under the maximum scenario is small compared to the increase in CO₂ emission foreseen for EDCs: the EIA foresees that the CO₂ emission of EDCs will grow from 8,400 Mton CO₂ per annum in 2003 to 16,100 Mton CO₂ per annum in 2020 (source: www.eia.doc.gov).

Figure 2.2 shows that small and medium hydro, bio-fuels, bio-energy and wind energy have the highest CO₂ reduction potential.
2.4. This is in line with and complementary to other studies

This paragraph provides the main conclusions of a comparison of the aforementioned results and conclusions of the RECIPES project with the outcome of other studies. The results of the following studies have been taken into consideration in this comparison:

- IEA / OECD, 2003: ‘Creating markets for energy technologies’;
- IEA, 2003: ‘Renewable energy… into the mainstream’;
- Martinot, E, 2002, ‘Renewable Energy markets in Developing Countries’;

Subject of the comparison are the following topics: contribution to socio-economic aspects of RE technologies compared to non-renewable technologies and the relative contribution of various RE options. For a comparison with regard to the CO₂ reduction potential of RE technologies, please refer to paragraph 1.5, as this topic is directly corresponding to the potential market volume.

2.4.1. RE technologies and job creation

The RECIPES survey identifies bio-energy as the best scoring technology with regard to job creation (closely followed by solar and hydro). This is confirmed by several other studies, including the UNDP publication ‘Sustainable Energy strategies – materials for decision makers’, which identifies biomass as a source of RE which is likely to have a relatively high impact both on the local socio-
economic and on the local environmental situation due to its land- and labour intensiveness. The Global Status Report 2005 published by REN21, reports that over 50% of all (1,700,000) jobs in RE are related to the production of bio fuels (a total of 900,000 direct jobs, of which 400,000 in Brazil). The second largest share, a further 15% of all jobs (250,000 jobs), is related to solar hot water production in China (REN21, 2005).

2.4.2. RE technologies and socio-economic impact in general
The potential socio-economic benefits (including job creation, income generation possibilities, health, education) in which the implementation of renewable energy options can result at a local level, is also underlined in the publication ‘Renewable energy… into the mainstream (IEA 2003). This report furthermore stresses the importance of various RE options that could replace the use of traditional biomass for cooking (such as advanced woodstoves) for the improvement of local health conditions.

The publication ‘Creating markets for renewable energy’ (IEA / OECD 2003) stresses that RE options are not necessarily better from a socio-economic or environmental perspective, this depends on the situation and on how they are implemented. Governmental actors should ensure that the development is steered in this direction where possible. This is also concluded in the publication ‘Renewable energy… into the mainstream’ (IEA 2003), which therefore stresses that national policy will have to address the important issue of stimulating technology options that have the least negative impacts / result in the largest improvements of the local environmental situation.

The conclusion that experts consider fossil and nuclear technologies less beneficial for socio-economic development than RE technologies, is thus confirmed (IEA 2003); it is however to be noted that this depends on whether these aspects are taken into consideration sufficiently by governmental actors.
3. An increased volume of renewable energy in emerging and developing countries presents opportunities for EU industry, but there is no low hanging fruit

This chapter reports on the opportunities for EU industry. The RE market potentials, presented in chapter 1, are used to identify the markets which are the most interesting for EU industry. Additional information on risks and on local RE industry, were also collected and taken into account.

3.1. Emerging and developing countries show an interesting RE market growth in 2020

As can be seen from chapter 1, significant market growth is expected for renewables in EDCs. In the following two tables these market expectations are compared with market expectations for the EU 15 countries.

Table 3.1: RE market in EDCs in 2003, RE market growth up to 2020, large hydro excluded (source: RECIPES)

<table>
<thead>
<tr>
<th></th>
<th>2003 contribution RE to TPES (Mtoe)</th>
<th>2020 market growth (ref scenario) (Mtoe)</th>
<th>2020 market growth (max scenario) (Mtoe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCO countries</td>
<td>95</td>
<td>87</td>
<td>250</td>
</tr>
</tbody>
</table>

Table 3.2: European RE market in 2000 and expected growth up to 2020 (source: EREC)

<table>
<thead>
<tr>
<th></th>
<th>2000 total inland consumption (Mtoe)</th>
<th>Market growth expectations by EREC (Mtoe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU 15</td>
<td>88</td>
<td>228</td>
</tr>
</tbody>
</table>

It should be noted that the underlying market potential studies of RECIPES and EREC are based on different assumptions, with different methodologies for the calculations and different time frames. However it can be concluded that the market for RE in emerging and developing countries is, in the maximum scenario, in the same order of magnitude as the market for the EU, which is one of the biggest markets in the world.

3.2. EU industry has to compete with local production and competitors from other economies.

Although the market potentials are significant, and in the same order of magnitude as in the EU, the opportunities for EU industry are limited because EU industry has to compete with domestic production and competitors from other economies, and also because of the restrictive non-technical conditions in some countries.

---

5 EREC, Renewable Energy Target for Europe; 20% by 2020, Brussels, 2004
The possibilities for export from the EU to emerging and developing countries can include goods and services; hardware and equipment as well as transfer of know-how, consultancy and training. All possibilities are looked at in the RECIPES project.

3.3. A number of risks and barriers are associated with doing business in emerging and developing countries

In this section some risks and barriers are described that are related to investing in renewables in emerging and developing countries.

We have distinguished different types of risks and barriers, the results of which lead to a certain level of opportunity for EU RE industry for doing business with a certain country for a specific technology:
- Country Risk Level general; Political and economic country stability (based on AON risk map);
- RE Industry and Import; Readiness of countries to participate in CDM projects, availability of import facilities and the openness of a country to import/foreign investments in general (information gathered by local experts in the 15 countries);

The following table shows the opportunity level for EU industry based on these types of risks and barriers.
Table 3.3: general opportunity level for EU industry in the 15 INCO countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Risk Level general</th>
<th>RE industry and import</th>
<th>Conditions for EU export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Brazil</td>
<td>medium-low</td>
<td>positive</td>
<td>high</td>
</tr>
<tr>
<td>Colombia</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Mexico</td>
<td>medium</td>
<td>neutral-positive</td>
<td>high</td>
</tr>
<tr>
<td>Peru</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Argentina</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Brazil</td>
<td>medium-low</td>
<td>positive</td>
<td>high</td>
</tr>
<tr>
<td>Colombia</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Mexico</td>
<td>medium</td>
<td>neutral-positive</td>
<td>high</td>
</tr>
<tr>
<td>Peru</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>China</td>
<td>medium</td>
<td>positive</td>
<td>high</td>
</tr>
<tr>
<td>India</td>
<td>medium</td>
<td>positive</td>
<td>high</td>
</tr>
<tr>
<td>Indonesia</td>
<td>medium-high</td>
<td>neutral</td>
<td>medium</td>
</tr>
<tr>
<td>Fiji Islands</td>
<td>medium-high</td>
<td>neutral-positive</td>
<td>medium</td>
</tr>
<tr>
<td>Kiribati</td>
<td>medium-low</td>
<td>neutral-positive</td>
<td>high</td>
</tr>
<tr>
<td>Thailand</td>
<td>medium</td>
<td>positive</td>
<td>high</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>medium</td>
<td>neutral-positive</td>
<td>high</td>
</tr>
</tbody>
</table>

3.4. Best opportunities for EU industry are in Asia, Pacific and Latin America. Africa is considered to be difficult, except South Africa

The following paragraphs present information per technology on the presently implemented volume, where this technology is manufactured and information about knowledge and organisational degree. Concerning the hardware, information is gathered on which parts are produced in the country and which are imported. For example for photovoltaic systems the hardware is divided into cells, frames, invertors and batteries. Then the opportunities and barriers for the different technologies are described.

Based on these descriptions, the best conditions for RE EU industry export are in Asia, Pacific and Latin America. Africa is considered to be difficult, except South Africa.
### 3.4.1. Wind energy

#### Table 3.4: present situation and scenarios wind energy in the 15 countries

<table>
<thead>
<tr>
<th>Wind</th>
<th>Present</th>
<th>Target</th>
<th>Scenarios 2020</th>
<th>Product manufactured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td></td>
<td>Ref Max</td>
<td>This country</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MW</td>
<td>yes/no and if available %</td>
</tr>
<tr>
<td>Argentina</td>
<td>27</td>
<td>Yes</td>
<td>315</td>
<td>7,500</td>
</tr>
<tr>
<td>Brazil</td>
<td>28</td>
<td>Yes</td>
<td>3,300</td>
<td>20,000</td>
</tr>
<tr>
<td>Colombia</td>
<td>19.5</td>
<td>No</td>
<td>90</td>
<td>1,250</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.6</td>
<td>No</td>
<td>105</td>
<td>9,400</td>
</tr>
<tr>
<td>Peru</td>
<td>0.7</td>
<td>Yes</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>China</td>
<td>570</td>
<td>No</td>
<td>7,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Pacific Islands</td>
<td>0.0</td>
<td>na</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>India</td>
<td>3000</td>
<td>Yes</td>
<td>12,500</td>
<td>20,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.4</td>
<td>na</td>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.7</td>
<td>Yes</td>
<td>135</td>
<td>330</td>
</tr>
<tr>
<td>Cameroon</td>
<td>pm</td>
<td>Yes</td>
<td>pm</td>
<td>pm</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.3</td>
<td>na</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Niger</td>
<td>pm</td>
<td>No</td>
<td>pm</td>
<td>0.6</td>
</tr>
<tr>
<td>South Africa</td>
<td>3.2</td>
<td>No</td>
<td>18</td>
<td>220</td>
</tr>
<tr>
<td>Uganda</td>
<td>pm</td>
<td>No</td>
<td>pm</td>
<td>pm</td>
</tr>
</tbody>
</table>

The important role of the EU wind energy industry in the world is visible in the 15 INCO countries. Our Chinese expert (of the Chinese Renewable Energy Industry Association CREIA) confirmed that China does not import wind turbines anymore. This technology in was imported in the past, but the new bidding rounds include the condition that the components must be manufactured in China, and a percentage by Chinese industry itself.

**Hardware Production:** Small wind turbines (<30 kW) are produced in Argentina, China, India and Thailand. Medium-sized wind turbines (up to 1 MW) are produced in China and Indonesia. Several other countries such as Brazil produce parts of the installations like blades or the towers.

**Capacity building:** all countries except Peru and Cameroon have a wind energy map available. Countries with smaller stand-alone systems often mention that there is a lack of maintenance capacity. Due to their large scale, wind farms have a comparative advantage: the transfer of know-how and skills is better organised than with systems scattered over a larger region.

Some countries, such as the African countries, Thailand, Indonesia, Colombia and Peru will, due to their realistic potential, probably not produce wind turbines but import most components. China and India already produce turbines and India exports them, so the EU industry will have to concentrate on joint ventures and export of services in these areas. Other countries like Brazil and Mexico may be interested in producing components of wind turbines domestically via investment from abroad or joint ventures with foreign parties.
Figure 3.1: opportunities EU industry wind energy in the 15 countries (under maximum scenario)

Opportunity for wind energy conditions for export

<table>
<thead>
<tr>
<th>Potential MWp</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>29,400 MW</td>
<td>own and import</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>20,000 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>17,000 MW</td>
<td>own and import</td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>9,400 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>7,500 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Colombia</td>
<td>1,250 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>330 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>200 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>100 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>65 MW</td>
<td>import</td>
<td></td>
</tr>
<tr>
<td>Uganda, Cameroon, Niger and Ghana</td>
<td>&lt; 1 MW</td>
<td>import</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.2: market potential wind energy in the 15 countries (under maximum scenario)

Market up to 2020 for Wind (GW)

- China, 29
- India, 17
- Other, 1
- Argentina, 7
- Mexico, 9
- Colombia, 1
- Brazil, 20
3.4.4. Small and medium hydro

Table 3.5: present situation and scenarios small/medium hydro in the 15 countries

<table>
<thead>
<tr>
<th>Small and medium hydro</th>
<th>Present</th>
<th>Scenarios 2020</th>
<th>Product manufactured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>Target</td>
<td>Ref Max</td>
</tr>
<tr>
<td></td>
<td>MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>80</td>
<td>No</td>
<td>350 550</td>
</tr>
<tr>
<td>Brazil</td>
<td>2500</td>
<td>Yes</td>
<td>3,250 12,500</td>
</tr>
<tr>
<td>Colombia</td>
<td>54</td>
<td>No</td>
<td>185 650</td>
</tr>
<tr>
<td>Mexico</td>
<td>154</td>
<td>No</td>
<td>230 1,900</td>
</tr>
<tr>
<td>Peru</td>
<td>39</td>
<td>Yes</td>
<td>46 86</td>
</tr>
<tr>
<td>China</td>
<td>35</td>
<td>No</td>
<td>68,000 80,000</td>
</tr>
<tr>
<td>Pacific Islands</td>
<td>6.6</td>
<td>na</td>
<td>1.2 1.2</td>
</tr>
<tr>
<td>India</td>
<td>1594</td>
<td>Yes</td>
<td>4,000 15,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>40</td>
<td>No</td>
<td>466 779</td>
</tr>
<tr>
<td>Thailand</td>
<td>300</td>
<td>Yes</td>
<td>966 966</td>
</tr>
<tr>
<td>Cameroon</td>
<td>na</td>
<td>Yes</td>
<td>0.2 5.3</td>
</tr>
<tr>
<td>Ghana</td>
<td>na</td>
<td>na</td>
<td>0.3 2.1</td>
</tr>
<tr>
<td>South Africa</td>
<td>34</td>
<td>No</td>
<td>100 1700</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.01</td>
<td>No</td>
<td>30 115</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hardware production: almost all countries which have micro and mini hydro systems produce the equipment in their own country, except countries which currently only have a few hydro power plants, like Cameroon:

- Small and medium systems (<10 MW) are produced in Brazil, China, Colombia, Indonesia and Mexico;
- Systems with a capacity between 10 and 25 MW are produced in Brazil, China and Indonesia.

Capacity building: the energy experts from the 15 countries confirmed that many small systems do not function optimally, due to neglected maintenance or a lack of finance to maintain and upgrade the plants properly. The knowledge and skills to maintain a hydro plant are available in all countries; however not always in the regions in which the hydro power plants are situated.

Most countries can currently produce essential parts of the hydro systems domestically, especially for smaller systems. However many countries are expected to be interested in services like refurbishment and maintenance programmes.

Larger systems were not studied in RECIPES; the definition of large hydro systems in the countries varies from 5-50 MW.
Figure 3.3: opportunities EU industry hydro in the 15 countries (under maximum scenario)

Opportunity for small and medium hydro

Chinese, 50,000 MW own
India, 13,500 MW own
Brazil, 10,000 MW own
Mexico, 1,750 MW own
South Africa, 1,700 MW own
Thailand, 700 MW own and import
Colombia and Indonesia, 560 MW own
Argentina, 470 MW own
Uganda, 115 MW own and import
Peru, 20 MW
Cameroon, Niger, and Ghana < 10 MW own and import

Figure 3.4 Market potential small and medium hydro in the 15 countries (under maximum scenario)

Market up to 2020 for small & medium hydro (GW)

- China, 52
- Brazil, 10
- India, 13
- Other, 6
### Solar thermal

#### Table 3.6: present situation and scenarios for solar thermal in the 15 countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Number installation</th>
<th>m²</th>
<th>Ref</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>12,000</td>
<td>24,000</td>
<td>15,000</td>
<td>31,000</td>
</tr>
<tr>
<td>Brazil</td>
<td>500,000</td>
<td>2.1 mil</td>
<td>1.2 mil</td>
<td>3.5 mil</td>
</tr>
<tr>
<td>Colombia</td>
<td>na</td>
<td>na</td>
<td>9,000</td>
<td>115,000</td>
</tr>
<tr>
<td>Mexico</td>
<td>300,000</td>
<td>600,000</td>
<td>750,000</td>
<td>1.3 mil</td>
</tr>
<tr>
<td>Peru</td>
<td>8,000</td>
<td>na</td>
<td>26,000</td>
<td>181,000</td>
</tr>
<tr>
<td>China</td>
<td>80 million</td>
<td>na</td>
<td>150 mil</td>
<td>150 mil</td>
</tr>
<tr>
<td>Pacific Islands</td>
<td>&gt;1000</td>
<td>na</td>
<td>pm</td>
<td>pm</td>
</tr>
<tr>
<td>India</td>
<td>0.7 mil</td>
<td>1 mil</td>
<td>1.3 mil</td>
<td>2 mil</td>
</tr>
<tr>
<td>Indonesia</td>
<td>150,000</td>
<td>400,000</td>
<td>350,000</td>
<td>2.8 mil</td>
</tr>
<tr>
<td>Thailand</td>
<td>50,000</td>
<td>na</td>
<td>57,500</td>
<td>165,605</td>
</tr>
<tr>
<td>Cameroon</td>
<td>pm</td>
<td>pm</td>
<td>300</td>
<td>3,700</td>
</tr>
<tr>
<td>Ghana</td>
<td>750</td>
<td>na</td>
<td>1,200</td>
<td>2,200</td>
</tr>
<tr>
<td>Niger</td>
<td>pm</td>
<td>pm</td>
<td>250</td>
<td>700</td>
</tr>
<tr>
<td>South Africa</td>
<td>165</td>
<td>750,000</td>
<td>1 mil</td>
<td>1.5 mil</td>
</tr>
<tr>
<td>Uganda</td>
<td>4,900</td>
<td>na</td>
<td>300</td>
<td>650</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>This country</th>
<th>North America</th>
<th>Europe</th>
<th>Asia</th>
<th>Australia</th>
</tr>
</thead>
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<tr>
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<td>No</td>
<td>No</td>
<td>No</td>
</tr>
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<td>Brazil</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mexico</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Pacific Islands</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>India</td>
<td>Yes</td>
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<td>No</td>
<td>Yes</td>
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</tr>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Thailand</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cameroon</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ghana</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Niger</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>South Africa</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Uganda</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Hardware production:** all countries except Brazil import parts (collectors, storage units) from abroad.

**Capacity building:** in all countries where solar thermal is present, there are companies providing installation and maintenance services, capacity is available.

The indicators show potential but due to the ‘simplicity’ of the installations many countries (emerging and industrialised) produce this technology. The opportunities for export of EU RE goods are thus limited.
Figure 3.5: opportunities EU industry for solar thermal in the 15 countries (under maximum scenario)

Opportunity for solar thermal

- China: 70 million own industry
- Brazil: 3 million own industry
- Indonesia: 2.65 million own and import
- South Africa: 1.5 million own and import
- India: 1.3 million own industry
- Mexico: 0.6 million own and import
- Peru: 175,000 own industry and import
- Thailand: 115,000 mostly own
- Colombia: 110,000 own and import
- Argentina: 19,000 own industry
- Uganda, Cameroon, Niger, and Ghana: < 10,000

Potential number installations:
- Low
- Medium
- High

Figure 3.6: market potential solar thermal in the 15 countries (under maximum scenario)

Market up to 2020 for Solar Thermal (1,000,000 installations)

- China: 70.0
- India: 1.3
- Indonesia, 2.7
- South Africa: 1.1
- Other: 0
- Brazil: 3.0
- Mexico: 0.8
### Photovoltaic

#### Table 3.7: present situation and scenarios PV in the 15 countries

<table>
<thead>
<tr>
<th>Photo voltaic</th>
<th>Present MWp</th>
<th>Target</th>
<th>Scenarios 2020 Ref MWp</th>
<th>Max MWp</th>
<th>This country product manufactured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>4.7</td>
<td>No</td>
<td>15</td>
<td>33</td>
<td>No</td>
</tr>
<tr>
<td>Brazil</td>
<td>5.2</td>
<td>No</td>
<td>50</td>
<td>130</td>
<td>Yes</td>
</tr>
<tr>
<td>Colombia</td>
<td>2.0</td>
<td>No</td>
<td>4</td>
<td>40</td>
<td>No</td>
</tr>
<tr>
<td>Mexico</td>
<td>15.1</td>
<td>No</td>
<td>16</td>
<td>57</td>
<td>No</td>
</tr>
<tr>
<td>Peru</td>
<td>1.9</td>
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<td>8</td>
<td>26</td>
<td>No</td>
</tr>
<tr>
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<td>50</td>
<td>No</td>
<td>300</td>
<td>1,000</td>
<td>Yes</td>
</tr>
<tr>
<td>Pacific Islands</td>
<td>0.3</td>
<td>0</td>
<td>2</td>
<td>4</td>
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</tr>
<tr>
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<td>83</td>
<td>Yes</td>
<td>105</td>
<td>145</td>
<td>Yes</td>
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<tr>
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<td>2.0</td>
<td>No</td>
<td>4</td>
<td>83</td>
<td>0</td>
</tr>
<tr>
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<td>24</td>
<td>Yes</td>
<td>273</td>
<td>274</td>
<td>Yes</td>
</tr>
<tr>
<td>Cameroon</td>
<td>0</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.9</td>
<td>No</td>
<td>1</td>
<td>7</td>
<td>No</td>
</tr>
<tr>
<td>Niger</td>
<td>1.0</td>
<td>Yes</td>
<td>2</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td>South Africa</td>
<td>6.5</td>
<td>No</td>
<td>10</td>
<td>25</td>
<td>Yes</td>
</tr>
<tr>
<td>Uganda</td>
<td>0.23</td>
<td>No</td>
<td>1</td>
<td>3</td>
<td>No</td>
</tr>
</tbody>
</table>

**Hardware production:**
- China, India and Thailand produce solar cells. The remaining countries’ ‘own production’ means they use imported cells and assemble the frame and invertors themselves.
- All countries import invertors, but half of the most developed countries also produce invertors.

**Capacity building:**
Almost all countries have had bad experiences with Solar Home Systems that failed, due to a lack of maintenance or inappropriate organisation. Nowadays most countries implementing this type of projects have adapted to the various lessons learned. There are also countries where energy service companies in which the PV-industry participates take care of whole projects, including maintenance and collection fee.

The African countries, Argentina and Peru will due to their realistic potential, probably not produce cells but can assemble solar systems with cells imported from abroad. The opportunities for export of goods and services are high. China and Thailand already produce cells and have intentions to increase exports. Other countries may be interested in producing them domestically via investment from abroad or joint ventures with foreign parties, or start more sophisticated assembly industries.
Figure 3.7: opportunities EU industry PV in the 15 countries (under maximum scenario)

Opportunity for photovoltaic

Potential MWp

- China, 930 MWp own and import
- Thailand, 550 MWp own and import
- Brazil, 125 MWp own and import
- South Africa 110 MWp own and import
- Indonesia 80 MWp own and import
- India, 62 MWp own and import
- Mexico 40 MWp own and import
- Colombia 38 MWp own and import
- Peru 30 MWp own and import
- Argentina 21 MWp own and import
- Uganda, Cameroon, Niger and Ghana < 10 MWp own and import

Conditions for export

Figure 3.8: market potential PV in the 15 countries (under maximum scenario)

Market up to 2020 for PV (GW)

- Thailand, 0.6
- South Africa, 0.1
- Indonesia, 0.1
- Brazil, 0.1
- Other, 0.2
- China, 0.9
3.4.5. **Bio energy**

For bio energy the picture is unclear. Energy produced from woody biomass and waste could not be assessed: for 8 countries it was possible to gather some information but the figures were not always reliable. Even fewer countries have information on potentials and policy. Furthermore, information on the production of equipment in the 15 countries is scarce.

The current scale of the bio-energy industry in developing and emerging countries determines whether it is viable to import equipment such as incineration installations and generators, or to produce it. This equipment is not specific to the RE industry. However, as some EU countries have large experience in this sector, EU industry might have opportunities for this technology. An example of a specific opportunity for this sector are CDM projects for exploiting landfill gas from waste sites in developing and emerging countries.

3.4.6. **Bio fuels**

Bio fuels are a relatively new type of energy for many countries. Targets are set for the short-medium term (2007, 2010 or 2012) and energy policy for bio fuels is generally under development. On the basis of the information available on the policies for bio fuels, we could assess 8 of the 15 countries.

However, there is a large range of uncertainty in the potentials; they could for instance well be higher due to:
- Rapid improvements in bio fuel technology;
- Opportunities to use new sources like (other types of) agro-waste;
- Recent and rapid changes in bio fuel policy.

The countries for which it was not possible to calculate market growth include some possibly interesting markets like China, Mexico and South Africa. For Colombia and Peru we could only roughly estimate the potential for bio fuels in general, not specified for ethanol and bio diesel.

The following market potentials for ethanol and bio diesel could be calculated.

<table>
<thead>
<tr>
<th>ethanol (billion l/year)</th>
<th>bio diesel (million l/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>present</strong></td>
<td><strong>2020</strong></td>
</tr>
<tr>
<td>Argentina</td>
<td>0</td>
</tr>
<tr>
<td>Brazil</td>
<td>15</td>
</tr>
<tr>
<td>Colombia</td>
<td>0</td>
</tr>
<tr>
<td>India</td>
<td>2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
</tr>
<tr>
<td>Pacifics</td>
<td>0</td>
</tr>
<tr>
<td>Thailand</td>
<td>0</td>
</tr>
</tbody>
</table>
The EU industry is currently not in a leading position. Other countries with more experience, like Brazil, have better prospects and are already active in other developing and emerging countries. Exports of goods from industry (manufacture of equipment) or export of services (like project management) to build bio fuel installations may offer opportunities for EU RE industry.

3.4.7. Geothermal energy
The potential for geothermal energy could not be fully assessed; only 6 out of the 15 countries studied the current use of geothermal energy. Information on perceived barriers and policy targets is not available. Only three countries have set a target for geothermal energy.

There is little information available on the production of the components for this technology. Countries, which only use heat, like Brazil and Argentina produce their own equipment. In countries where electricity is generated, equipment is also produced within the country itself, although large turbines may sometimes be imported.

The opportunities for the EU industry are, besides the export of turbines and other components to produce electricity, in the field of consultancy for site selection, proof drilling and organisation of the project achievement. In all areas of geothermal energy (electricity, heating, cooling), the opportunities focus on equipment for geothermal installations, such as heat pumps, circulation pumps, tubes and control systems.

3.5. This is in line with and complementary to other studies
The following paragraphs provide the main conclusions of a comparison of the aforementioned results and conclusions of the RECIPES project with the outcome of other studies. The results of the following studies have been taken into consideration in this comparison:
- IEA (2003): ‘Renewable energy… into the mainstream’;
- Martinot E. (2002), ‘Renewable Energy markets in Developing Countries’;

The results are compared with regard to the following issues:
- Market growth in a number of emerging and developing countries for different renewable technologies and competition with local production and other economies;
- Risks and barriers that are associated with doing business in emerging and developing countries;
- Countries and regions that show the best opportunities for EU industry.
3.5.1. Market growth potential for RE technologies and competition

In the RECIPES project, a number of conclusions have been formulated with regard to market potentials of different technologies (and the share of this volume that is likely to be achieved with locally produced technologies). The Renewables Global Status Report (GSR) published by REN21 also addresses this issue. The following provides a comparison of the outcome of both reports regarding three main technologies: wind energy, PV and bio fuels:

- **For wind energy**, RECIPES concludes that the opportunities in China and India are good but that both countries produce (and in the case of India also export) wind turbines, so the EU industry has to concentrate on joint ventures and export of services in these areas. The GSR reports an impressive increase of domestic production in China, and mentions the event of the first fully domestically developed turbine in this country. Furthermore, it reports that leading companies in the wind energy sector from the EU, the US and India have recently invested in manufacturing facilities in China.

- **With regard to the PV industry**, RECIPES concludes that there is a certain potential for the technology that offers good opportunities for export of goods and services. Several countries, with high realistic potentials for this RE option will however likely start (or, in the case of China and Thailand, already have started) to produce cells domestically. China is seen as the country with the largest potential and best opportunities. The GSR reports that Japan and Europe are in the lead in this technology. China is currently in third position with a very high-expected growth (almost equal to current global production) in the coming years (up to 2010).

- **Concerning bio fuels**, RECIPES concludes that the EU industry is currently not in a leading position. Other countries with more experience, like Brazil, have higher prospects and are already active in other developing and emerging countries. Many countries are currently formulating bio fuels policies. Exports of goods or services to build bio fuel installations offer opportunities for the EU industry. The GSR reports that Brazil will retain its leading position in ethanol, mainly as a result of a national plan to increase sugar cane production with 40%. With regard to bio diesel, the GSR reports a leading position for the EU.

3.5.2. Risks and barriers associated with doing business in EDCs

There are several studies that have addressed the issue of risks and barriers for the implementation of RE in developing countries, especially regarding non-technical issues. The lack of a strong supporting national policy is perceived as an important barrier. The availability of a clear national policy and targets (including financial measures) with regard to RE options is seen as a crucial factor for the implementation of renewable energy by various studies: it is concluded in the RECIPES project as well as in the European Renewable Energy Export Strategy (EREC 2002), the IEA publication ‘Renewable energy… into the mainstream”; the UNDP report ‘Sustainable Energy strategies – materials for decision makers’ and ‘Renewable Energy markets in Developing Countries’ (Martinot, 2002).
With regard to these policies it is furthermore stressed that all relevant stakeholders should be involved in formulating and implementing them (IEA / OECD, 2003), to ensure that a sound local support structure is available and that the options are well suited to their intended end-users. This is concluded in the publications by Martinot (2002) and UNDP (2000). The latter publication furthermore mentions that from the perspective of RE industry, building solid partnerships with local partners is seen as a successful way of securing an effective and efficient local support strategy. An important failure factor in the past has been that the energy systems implemented were not suited to their intended user, either by a misfit of supply and demand or by lacking maintenance and support structures.

Finally, an important risk that is discussed in the publications ‘Renewable Energy markets in Developing Countries’ (Martinot, 2002) and ‘Sustainable Energy strategies – materials for decision makers’ (UNDP, 2000) is the risk of a market driven approach to be potentially highly successful in a market where consumers are (starting to be) able to afford energy or generate income from it, while the poorest (both within the country as well as the poorest markets) will be lagging behind. This issue will require the continuous attention of governmental actors / policy makers at mainly the national and international level.

The market potential study carried out in RECIPES appears to confirm this image by showing that in the relatively more developed markets RE implementation is accelerating at a high pace, while in the poorest countries generally little growth is expected in the coming decades. However, in some cases also an adverse effect of the existence of a relatively wealthy part of society is noted in the RECIPES study: in some cases this section of society regards renewable energy options as second best (for instance because a grid connection is preferred) which may hamper their implementation.

3.5.3. Countries / regions with the best opportunities for EU industry
In the beginning of this chapter the potentials that have been established in the RECIPES project per technology and per country are described. The most comparable study with respect to this aspect is the European Renewable Energy Export Strategy (EUREES), published by EREC in 2002. Although this study is not focusing in particular on EDCs, there is a large similarity between the countries that have been identified by both studies as interesting export markets for EU industry. Brazil, China and India are regarded as the most interesting current markets for EU RE technology (EREC 2002).

A potentially important role for EU industry is identified in both studies to fulfil the potential of renewables in energy supply, significant economic benefits can be achieved in the EU as a result (competitive position, job creation in various sectors including energy related R&D, technology suppliers, service providers, installing and maintenance). This is also confirmed by the publication ‘Renewable energy… into the mainstream’ of the IEA (2003).
Annexes

Annex A – Recommendations for stakeholders

RECIPIES follow-up:

- Main desired follow up is in our view to facilitate dialogues about the results of this project, for instance a dialogue within a country between its energy actors, a dialogue of cooperation programmes with country representatives and a dialogue within existing networks like REEEP. The EC might wish to support this, for instance by organising local workshops or by using the RECIPIES results within cooperation programmes.

- Another follow-up might be to extend the study with other country studies, especially in poor countries that are of special interest for the EC’s international cooperation programmes.

- Finally, a regular update of the data could be done and transferred into the EC input or the EC reference work for policy discussions on the subject.

European Commission (DG ENV, EuropeAid, DG RES)

- **Exchange of knowledge leads to new and improved RE solutions adapted to the EDC context, better understanding of the barriers and opportunities of RET’s and an improved implementation approach.** Unfamiliarity with the available information and access to this information is identified as a major barrier for implementing RE in EDCs. It is therefore important that the exchange of technology, know-how, education, training programmes, information, statistics and data is promoted, on best available environmentally sound energy technologies, performance standards, safety codes as well as relative and absolute energy costs. The EC might consider setting up training and exchange programmes for energy scientists, energy policy makers and planners of EDCs and EU, at the benefit of both.

- **Lowering implementation costs of RET’s in EDCs can be an important driver for increased investments.** The implementation costs of RET’s in EDCs are relatively high when compared to costs in developed countries and can, in some instances, be almost as high as the hardware. Foreign investors and RE industry are therefore reticent. The EC might foresee a financial facility aimed at lowering the implementation costs (training, setting-up, integration in local social context, financing structure) and thereby stimulating the EU energy sector to invest in RE projects in EDCs.

- **Energy technology cooperation is beneficial for both the developing and developed countries and therefore should be a cornerstone of North-South cooperation programmes.** Energy is an enabler for development in EDC’s. There is a broad consensus that RET’s have a higher contribution to the local socio-economic development and environmental situation than non-RET’s. Also, both industrialised and developing countries are bound together to reduce CO₂ emissions, which for a large part are caused by the production and use of energy. This makes that clean energy (low emission
technologies) should in our opinion be at the heart of cooperation programmes. EC cooperation programmes might for instance make RE a preferred technology in development cooperation projects.

- **R&D and technology transfer have an important role to play.** As new technologies will have a major role in a foreseen global energy system, the role of R&D and technology transfer is important as well. Special attention should be given to socio-economic benefits in EDCs of investment in RE, compared to investment in traditional energy technologies. Comparison of countries; identification of tangible socio-economic benefits.

- **Special attention for the poorest.** Governmental actors at the international level should give intensified attention to the poorest countries, as these are the ones likely to be lagging behind when a market-driven approach is chosen. Actors in these markets are often unable to compete on the technology learning curve.

**Energy actors in EDCs**

- **Develop a tailor made RE policy for your country.** Although a lot of good examples for RE policies can be found in many countries, an energy policy should be adapted to the national context. RE policy should be integrated in other (country specific) policies like energy, economic and social development, environment, electrification and poverty eradication.

- **Create an attractive financial climate for RE.** In order to attract RE investors and RE knowledge, it is important to create an attractive investment climate for local and foreign organisations: robust RE legislation and policy, high quality RE institutions and long lasting financial incentives. Focus must be on the RE technologies that have the highest local socio-economic benefits. Nurturing local RE industry gives local benefits. This can coincide with attracting foreign investors into this industry.

- **Shift the path of your financial flows towards long-term energy solutions.** Rapid growth of energy demand means that investments will be done in the energy infrastructure. The incremental cost of de-carbonising the power sector in the developing countries, according to World Bank research, is 10% of the total investment need for energy. This extra cost avoids investing in energy technologies that risk being outdated soon. Costs of inaction are much higher. Also the independence of fossil fuels from other countries can be important in the near future as energy prices are likely to stay high or even increase and some of these countries are politically unstable.

- **Make a point of knowledge transfer.** Knowledge transfer is crucial for the success of RE policy and includes, inter alia:
  - Information and general training to national and local government officials;
  - Specific information and training to local energy actors;
○ Implementation and enforcement of energy and environmental standards;
○ Programmes for grants and concessional loans;
○ Promotion of joint ventures and licensing agreements;
○ Support to incremental innovations.

EU RE industry

Local partnerships lead to success. Technology providers increase their chances of success when ensuring solid partnerships with local partners (at which knowledge and capacities are built to ensure maintenance and other service tasks can be carried out properly). Working with local partners also can decrease implementation costs.

Implementation activities are part of the job: it is important to integrate implementation activities and costs in the project set-up (training, setting-up, integration in local social context, financing structure). Failure of RE projects is in most cases linked to implementation and not meeting user needs. Failure damages the image of RE and labels it as second best.

There’s no logic for developing RE in unstable environments. Success factors for stimulating RE technologies in EDCs with public funds are: strong commitment from local partners, highly motivated technology providers, patience and long-term commitment. There is no business logic in developing advanced technologies in unstable environments.
### Annex B – Emerging and developing countries (INCO list)

The 114 countries of the INCO list: ACP (African, Caribbean and Pacific), Asia and Latin America (INCO work programme)

<table>
<thead>
<tr>
<th>AFRICAN (48)</th>
<th>ASIA (18)</th>
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<tbody>
<tr>
<td>Angola</td>
<td>Swaziland</td>
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<tr>
<td>Benin</td>
<td>Tanzania</td>
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<td>Botswana</td>
<td>Togo</td>
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<td>Burkina-Faso</td>
<td>Uganda</td>
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<td>Burundi</td>
<td>Zambia</td>
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<td>Cameroon</td>
<td>Zimbabwe</td>
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<td>Cape Verde</td>
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<td>Central African Republic</td>
<td>CARIBBEAN (16)</td>
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<td>Chad</td>
<td>Antigua and Barbuda</td>
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<tr>
<td>Comoros</td>
<td>Bahamas</td>
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<tr>
<td>Congo (Republic)</td>
<td>Barbados</td>
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<tr>
<td>Congo (Democratic Rep. of)</td>
<td>Belize</td>
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<tr>
<td>Côte d'Ivoire</td>
<td>Cuba</td>
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<td>Djibouti</td>
<td>Dominica</td>
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<td>Equatorial Guinea</td>
<td>Dominican Rep.</td>
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<td>Ghana</td>
<td>Saint Kitts and Nevis</td>
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<td>Guinea</td>
<td>Saint Lucia</td>
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<td>Guinea-Bissau</td>
<td>Saint Vincent and Grenadines</td>
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<td>Kenya</td>
<td>Suriname</td>
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<td>Trinidad and Tobago</td>
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<td>Madagascar</td>
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<td>Marshall Islands</td>
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<td>Namibia</td>
<td>Micronesia, Federal States of</td>
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